

SMOKY HILL/SALINE RIVER BASIN TOTAL MAXIMUM DAILY LOAD

**Water Body/Assessment Unit: Upper Kansas River, Lower Smoky Hill River, Lower Saline River,
including Wolf Creek
Water Quality Impairment: Chloride**

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasins: Upper Kansas, Lower Smoky Hill & Lower Saline

Counties: Geary, Dickinson, Saline, Ottawa, Lincoln, Russell, McPherson, Clay & Ellsworth

HUC 8: 10260008, 10260010 & 10270101

Ecoregion: Central Great Plains, Smoky Hills (27a)
Flint Hills (28)

Drainage Area: Approximately 3,436 square miles from Kanopolis and Wilson Dams to Ft. Riley/Ogden.

Water Quality Limited Segment on Upper Kansas River: 7

Water Quality Limited Segments on Lower Smoky Hill River: 1, 2, 6, 9, 10, 11 & 12

Water Quality Limited Segments on Lower Saline River: 1, 2, 3, 4, 5, 9 & 13

Water Quality Limited Segments in Wolf Creek Watershed: 10, 11, 12, 30, 31 & 33

Watershed Hierarchy of Main Stem and Tributary Segments Monitored by KDHE Stations (Figure 1)

HUC 8 10270101 – Upper Kansas

Watershed: Upper Kansas River above Ogden

Station 518 Kansas River (7) Three Mile Creek (15)

HUC8 10260008 – Lower Smoky Hill

Watershed: Smoky Hill River (Junction City)

Station 264 Smoky Hill R (1)
Smoky Hill R (2)

Watershed: Lyon Creek

Station 516	Lyon Cr (31)	Otter Cr (42)	
		Unnamed Stream (638)	
		W.Branch Lyon Creek (34)	Unnamed Stream (515)
		Lime Cr (51)	Unnamed Stream (618)
	Lyon Cr (540)	Unnamed Stream (542)	

Watershed: Carry Creek

Station 708 Carry Cr (35)

Unnamed Stream (32)

Watershed: **Chapman Creek**

Station 515 Chapman Cr

Basket Cr (40)

West Chapman Cr (5)

Chapman Cr

Watershed: **Smoky Hill River (Enterprise)**

Station 265 Smoky Hill R (6)

Lone Tree Cr (41)

Smoky Hill R (9)

Smoky Hill R (10)

Smoky Hill R (11)

Smoky Hill R (12)

Watershed: **Turkey Creek (Abilene)**

Station 644 Turkey Cr (28)

W. Branch Turkey Cr (29)

Turkey Cr (30)

E. Turkey Cr (50)

Middle Branch (58)

Watershed: **Mud Creek (Abilene)**

Station 643 Mud Cr (8)

Watershed: **Holland Creek**

Station 642 Holland Cr (25)

E. Holland Cr (27)

W. Holland Cr (26)

Watershed: **Gypsum Creek**

Station 641 Gypsum Cr (18)

W. Branch Gypsum Cr (44)

Spring Cr (45)

McAllister Cr (49)

Hobbs Cr (48)

Stag Cr (19)

S. Gypsum Cr (24)

Battle Cr (23)

N. Gypsum Cr (57)

Gypsum Cr (20)

Gypsum Cr (21)

Gypsum Cr (22)

Watershed: **Smoky Hill River (Salina/Mentor)**

Stations: 268, 514 Smoky Hill R (13)

E. Dry Cr (43)

Dry Cr (36)

Pewee Cr (56)

Kentucky Cr (17)

W. Kentucky Cr (54)

Paint Cr (52)

Sharps Cr (16)

Wiley Cr (47)

Smoky Hill R (14)

Smoky Hill R (15)

HUC 8 10260010 – Lower SalineWatershed: **Saline River (New Cambria)****Station 267 Saline R (1)****Saline R (2)****Saline R (3 – lower)**

Shaw Cr (41)

Owl Cr (18)

Watershed: **Mulberry Creek (Salina)****Station 640 Mulberry Cr (19)****Mulberry Cr (20)****Mulberry Cr (21)****Mulberry Cr (22)**

Dry Cr (29)

Spring Cr (24)

Spring Cr (26)

Spring Cr (27)

Eff Cr (23)

Table Rock Cr (40)

W. Spring Cr (25)

Ralston Cr (28)

Watershed: **Saline River (Beverly)****Station 513 Saline R (3 – upper)****Saline R (4)****Saline R (5)****Saline R (9)****Saline R (13)**

Twelvemile Cr (36)

Yauger Cr (35)

Lost Cr (34)

West Twin Cr (37)

Watershed: **Elkhorn Creek****Station 671 Elkhorn Cr (17)**

W. Elkhorn Cr (38)

Watershed: **Bullfoot Creek****Station 672 Bullfoot Cr (14)****Bullfoot Cr (15)**

Spring Cr (16)

Watershed: **Spillman Creek****Station 673 Spillman Cr (6)**

Trail Cr (32)

Bacon Cr (7)

N. Br. Spillman Cr (8)

Watershed: **Wolf Creek (Sylvan Grove)****Station 537 Wolf Creek (10)**

Blue Stem Cr (33)

E. Fk. Wolf Cr (11)

W. Fk. Wolf Cr (12)

Fourmile Cr (30)

Coon Cr (31)

Designated Uses of Impaired Streams: Upper Kansas River: Primary B Recreation; Special Aquatic Life Support, Domestic Water Supply; Food Procurement; Groundwater Recharge, Industrial Water Supply, Irrigation; Livestock Watering. Smoky Hill and Saline Rivers same, except Primary C Recreation and Expected Aquatic Life Support.

Expected Aquatic Life Support Secondary b Recreation on streams in Wolf Creek Watershed; Food Procurement on Segments 10, 11 & 12.

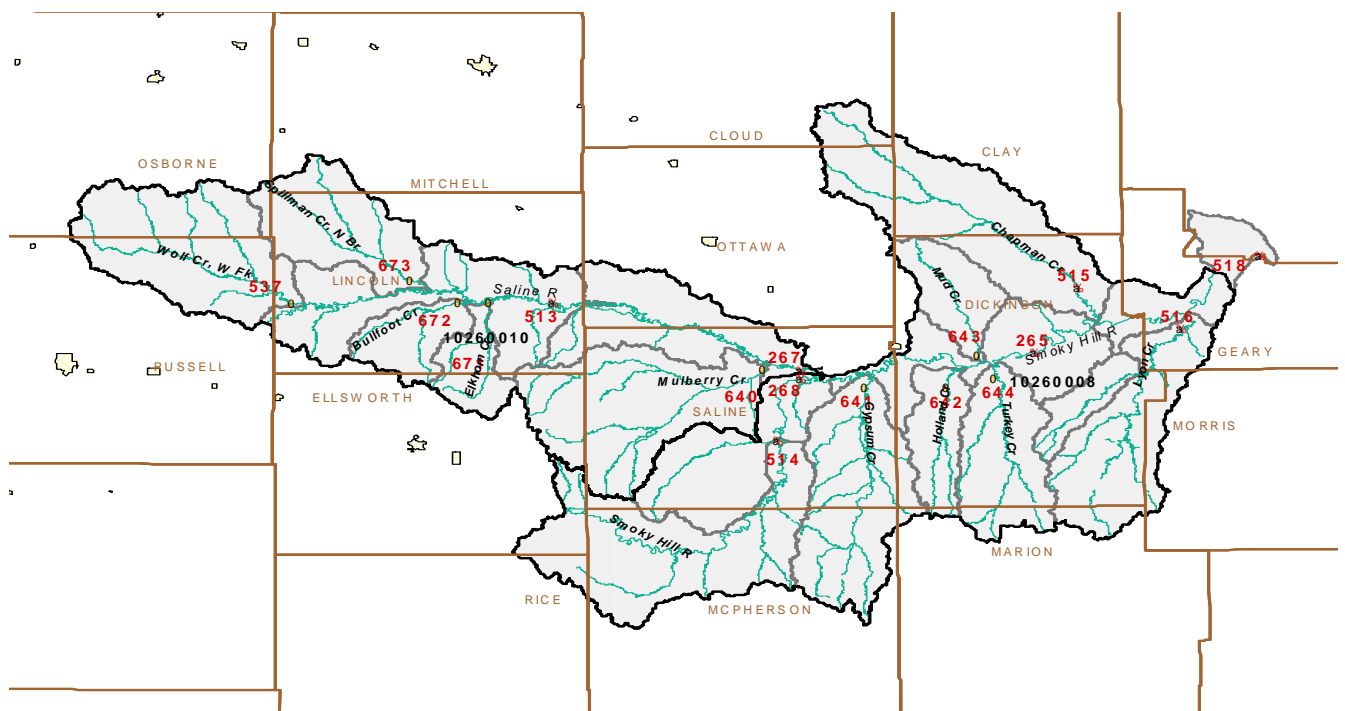
2002 303(d) Listing: Smoky Hill/Saline River Basin Streams

Impaired Use: Domestic Water Supply; Acute Aquatic Life Support

Water Quality Standard: Domestic Water Supply: 250 mg/L at any point of domestic water supply diversion (K.A.R.28-16-28e(c) (3) (A)); Acute Aquatic Life Support: 860 mg/l (K.A.R. 28-16-28e(c) (2) (F) (ii)).

In stream segments where background concentrations of naturally occurring substances, including chlorides and sulfates, exceed the water supply criteria listed in table 1a in subsection (d), at ambient flow, the existing water quality shall be maintained, and the newly established numeric criteria shall be the background concentration, as defined in K.A.R. 28-16-28b(e). Background concentrations shall be established using the methods outlined in the “Kansas implementation procedures: surface water quality standards,” as defined in K.A.R. 28-16-28b(ee), available upon request from the department. (K.A.R. 28-16-28e(b) (9))

Figure 1. Base Map of TMDL Area – Upper Kansas, Lower Smoky Hill & Lower Saline



2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 2002 303(d): Not Supporting Domestic Water and Partially Supporting Aquatic Life

Streamflow and Water Quality Monitoring Sites: Table 1 indicates the USGS Stream Gaging Stations and KDHE Ambient Stream Water Quality Monitoring Stations used in this TMDL. Data from the coincidental period of record for streamflow and water quality sampling of 1990 to 2003 were used, whenever available. While the entire drainage was assessed for excessive chloride, the TMDL concentrated on the impaired streams of the Kansas River at Ogden, the Smoky Hill River from Junction City to New Cambria, the Saline River from New Cambria to Wilson Dam and Wolf Creek from Sylvan Grove to its headwaters. The major tributaries to the Smoky Hill and Saline Rivers were also monitored, albeit on a rotational basis for the most part. Those stations had three to four years of data available with sample sizes of 15 to 23. Gaging stations are located evenly throughout the watershed and flow estimates were made from USGS extrapolation studies. A number of the gaging stations had chloride data collected before 1990 as part of USGS mineral intrusion studies on the Saline and Smoky Hill Rivers (Gillespie and Hargadine, 1981, 1986).

Current Condition: Starting on the Kansas River at Ogden, chloride concentrations have a generally inverse relation with flow (Figure 2). There is tremendous scatter in the sample data, weakening any linear relationship with streamflow. Nonetheless, chloride exceedances over 250 mg/l cease once flows reach 35 percent exceedance levels. Flows exceeded at least 80 percent of time rarely have chloride levels below 250 mg/l. High chloride levels of 400 mg/l or more can be seen at moderate flow levels (60 percent exceedance).

Two principal streams comprise the flow at Ogden; the Republican River as released from Milford Dam above Junction City and the Smoky Hill River arriving from the west of Junction City. The chloride loads are carried by the Smoky Hill River. Comparison of chloride levels at Junction City and Ogden indicates a general pattern of dilution between Ogden and Junction City (Figure 3). The Republican River is the main dilution base and releases from Milford Reservoir serve to support downstream flows along the Kansas River. The pattern of dilution strengthens when comparing Ogden and Junction City chloride levels with those on the Smoky Hill River at Enterprise (Figures 4 & 5).

The presence of elevated chloride is more pervasive at Enterprise (Figure 6). Only high flows exceeded 25 percent of the time or less see consistently low chloride levels. On the opposite hydrologic condition, flows exceeded 60% of the time or more never have chloride concentrations below 250 mg/l. Extremely low flows will have chloride exceedances over the acute aquatic life criterion of 860 mg/l.

Tributaries to the Smoky Hill River in Dickinson and Geary counties have low chloride content. The next major tributary is the Solomon River joining the Smoky Hill River west of Abilene. The Solomon River has elevated chlorides under flow conditions exceeded more than half the time (Figure 7). Chloride levels below 250 mg/l are not seen until flow conditions improve to the 75 percentile.

Table 1. Stream Gages and Monitoring Stations on the Lower Smoky Hill and Saline Rivers

Station	Stream	Type	Record	Med Q (cfs)	Avg Cl (mg/l)	Max Cl (mg/l)	# of Samples	# >250 mg/l	# > 860 mg/l
Ogden/Ft. Riley (518)	Kansas River	Q/WQ	1990-2003	1220	194	549	144	39	0
Junction City (264)	Smoky Hill R.	WQ	1996-8, 2003	ND	216	654	83	28	0
Enterprise (265)	Smoky Hill R.	Q/WQ	1990-2003	727	347	1264	84	51	3
Lyon Crk (516)	SH R. Trib	WQ	1990-2003	40	29	55	79	0	0
Carry Crk (708)	Lyon C Trib	WQ	1994, 98, 2002	14	23	34	16	0	0
Chapman Crk (515)	SH R. Trib	Q/WQ	1990-2003	24	26	41	80	0	0
Turkey Crk (644)	SH R. Trib	WQ	1991, 95, 99, 2003	31	39	55	20	0	0
Mud Crk (643)	SH R. Trib	WQ	1991, 95, 99, 2003	2.3	41	70	21	0	0
Holland Crk (642)	SH R. Trib	WQ	1991, 95, 99, 2003	4.8	69	157	23	0	0
Gypsum Crk (641)	SH R. Trib	WQ	1991, 95, 99, 2003	6.3	79	162	20	0	0
Niles (266)	Solomon R.	Q/WQ	1990-2003	223	226	511	80	35	0
New Cambria	Smoky Hill R.	Q	1990-2003	400	ND	ND	ND	ND	ND
Salina (268)	Smoky Hill R.	WQ	1990-2003	ND	154	250	80	0	0
Mentor (514)	Smoky Hill R.	Q/WQ	1990-2003	74	155	255	79	1	0
New Cambria (267)	Saline R.	WQ	1990-2003	ND	319	741	79	52	0
Mulberry Crk (640)	Sal R. Trib	WQ	1991, 95, 99, 2003	19	68	422	22	1	0
Tescott/Beverly (513)	Saline R.	Q/WQ	1990-2003	70	387	898	80	67	1
Elkhorn Crk (671)	Sal R. Trib	WQ	1993, 97, 2001	3.9	52	69	15	0	0
Bullfoot Crk (672)	Sal R. Trib	WQ	1993, 97, 2001	3.6	100	148	16	0	0
Spillman Crk (673)	Sal R. Trib	WQ	1993, 97, 2001	4.7	76	119	15	0	0
Wolf Crk (537)	Sal R. Trib	WQ	1990, 94, 98, 2002	5.6	415	962	21	13	2
Wilson Dam	Saline R.	Q	1990-2003	20	ND	ND	ND	ND	ND

The Saline River joins the Smoky Hill River in the vicinity of New Cambria, east of Salina. The chloride content of the two rivers above their confluence is markedly different (Figures 8 & 9). The Saline River as measured in the Beverly/Tescott and New Cambria areas is consistently high in chloride, concentrations below 250 mg/l are not seen at Beverly until median (50%) flow is reached, although there is some dilution seen between Beverly and New Cambria. The Smoky Hill River at Salina and Mentor is low in chloride, with only one sample exceeding 250 mg/l. Wolf Creek near Sylvan Grove, a tributary to the Saline River, is also high in chloride (Figure 10).

Examination of chloride data collected by USGS prior to 1990 indicates high concentrations historically. Table 2 indicates average chloride levels seen at certain USGS gaging station in the 1960's are not significantly different in average concentration than the contemporary KDHE stations, sampling since 1990. Therefore, there is no evidence of irrigation impacts on stream chloride concentrations.

Figure 2. Kansas River at Ogden Chloride-Flow Relationship

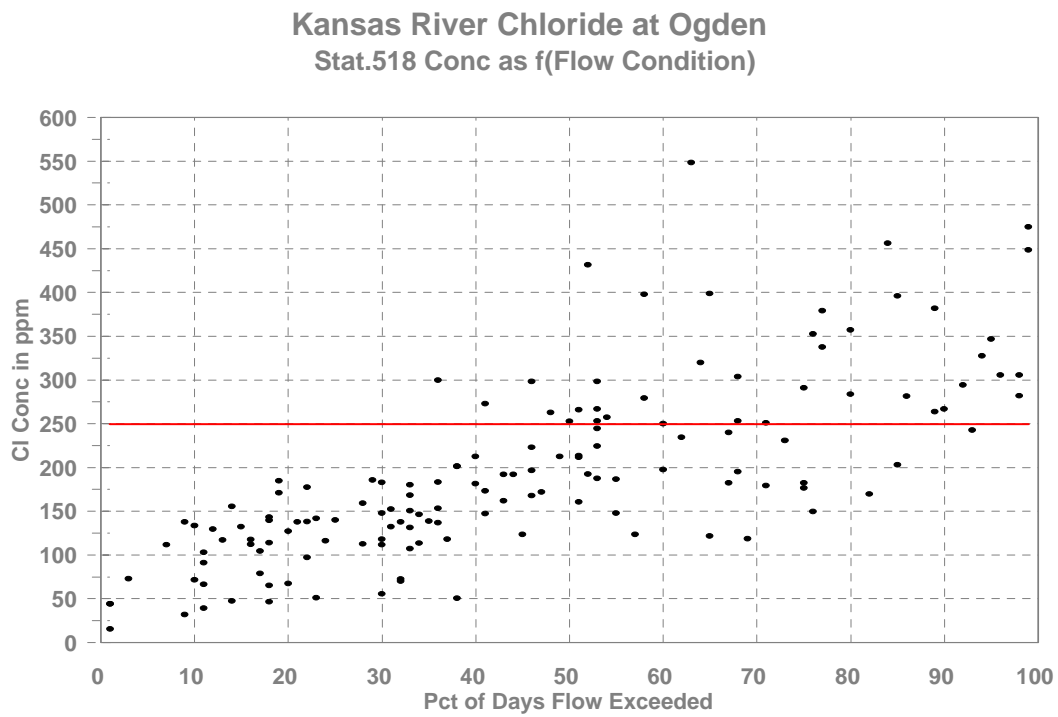


Figure 3. Chloride Relationship between Junction City and Ogden

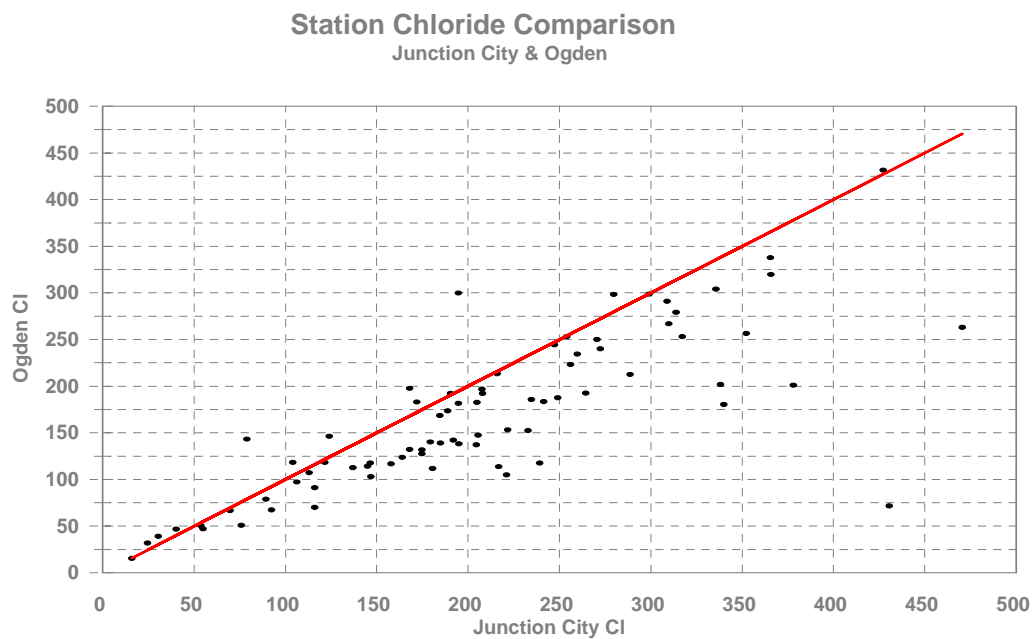


Figure 4. Chloride Relationship between Enterprise and Ogden

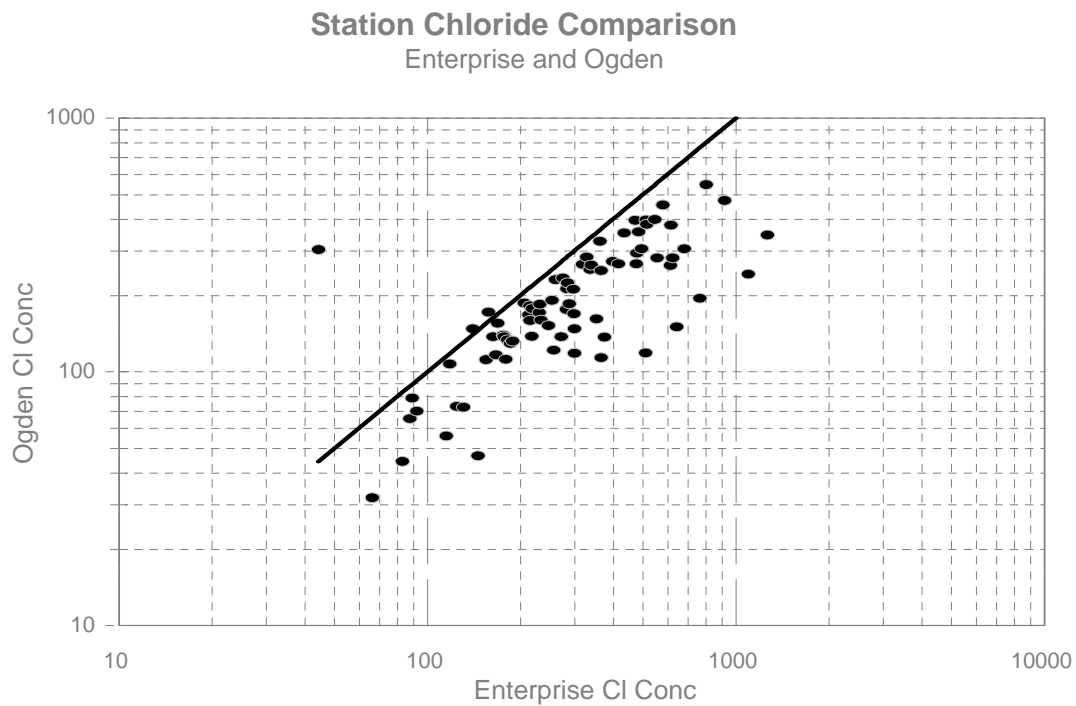


Figure 5. Chloride Relationship between Enterprise and Junction City

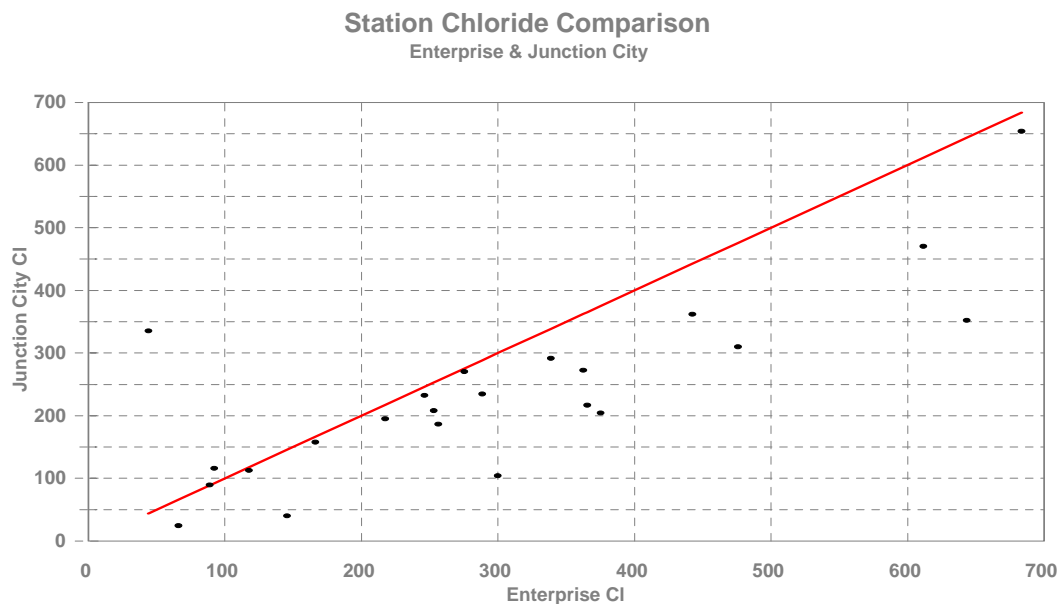


Figure 6. Smoky Hill River at Enterprise Chloride – Flow Relationship

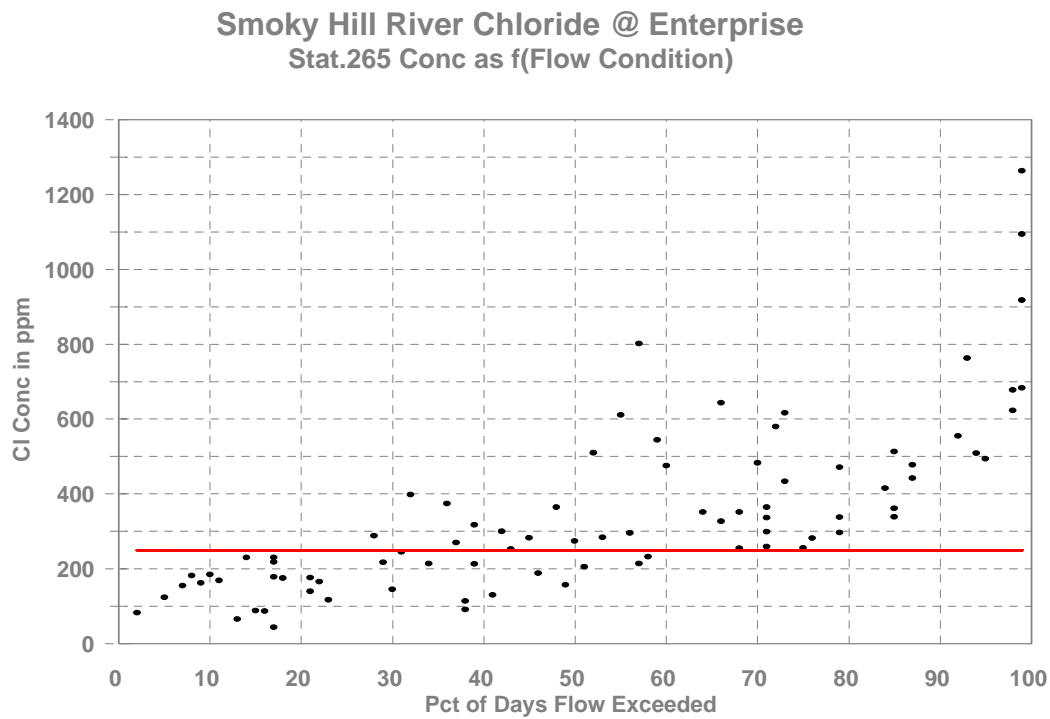


Figure 7. Solomon River near Niles Chloride – Flow Relationship

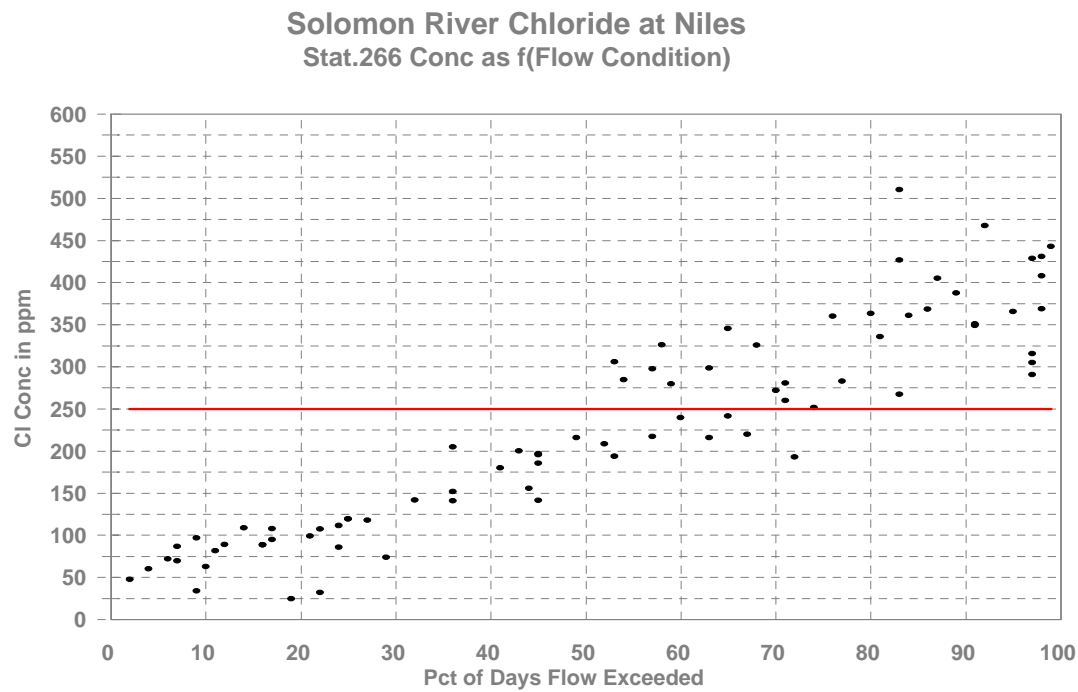


Figure 8. Saline River at Beverly and New Cambria Chloride – Flow Relationship

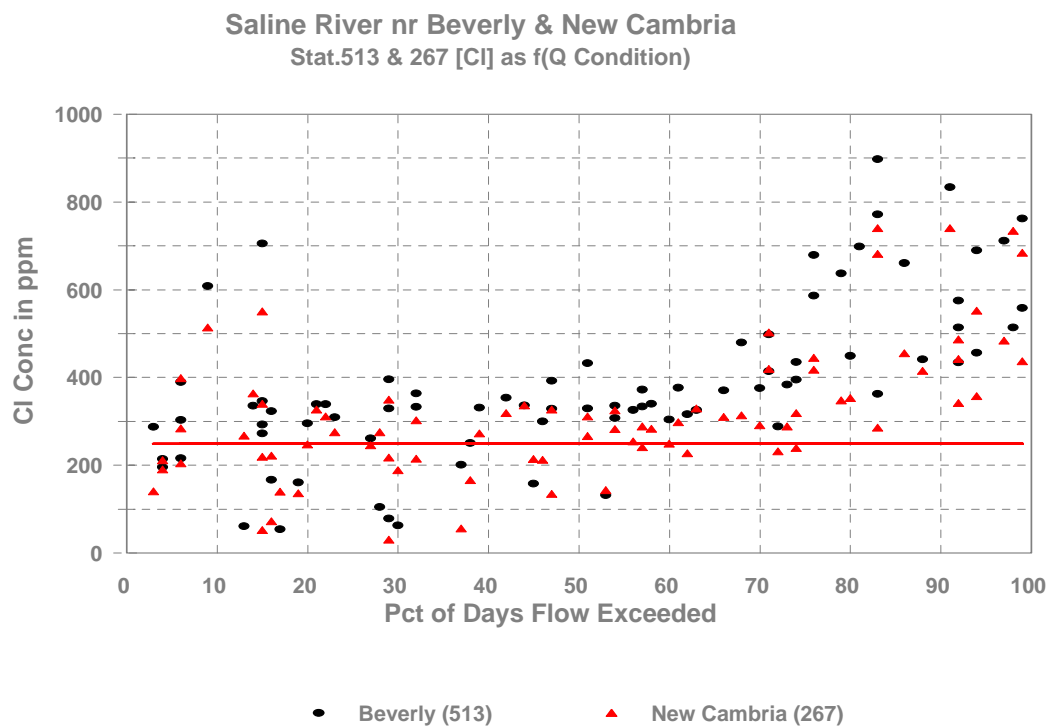


Figure 9. Smoky Hill River near Mentor Chloride – Flow Relationship

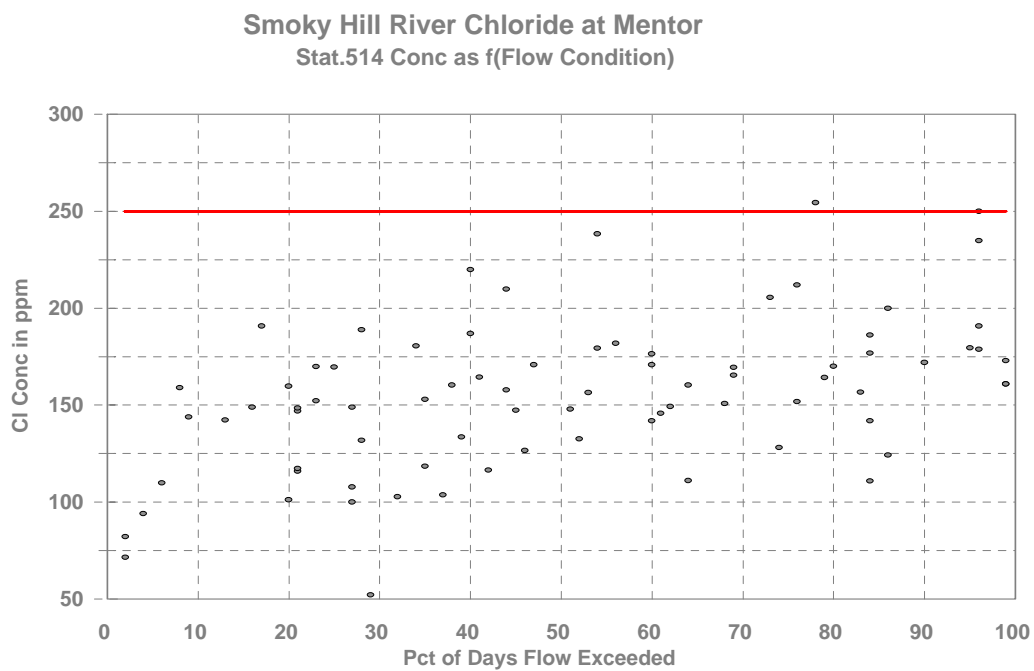


Figure 10. Wolf Creek near Sylvan Grove Chloride – Flow Relationship

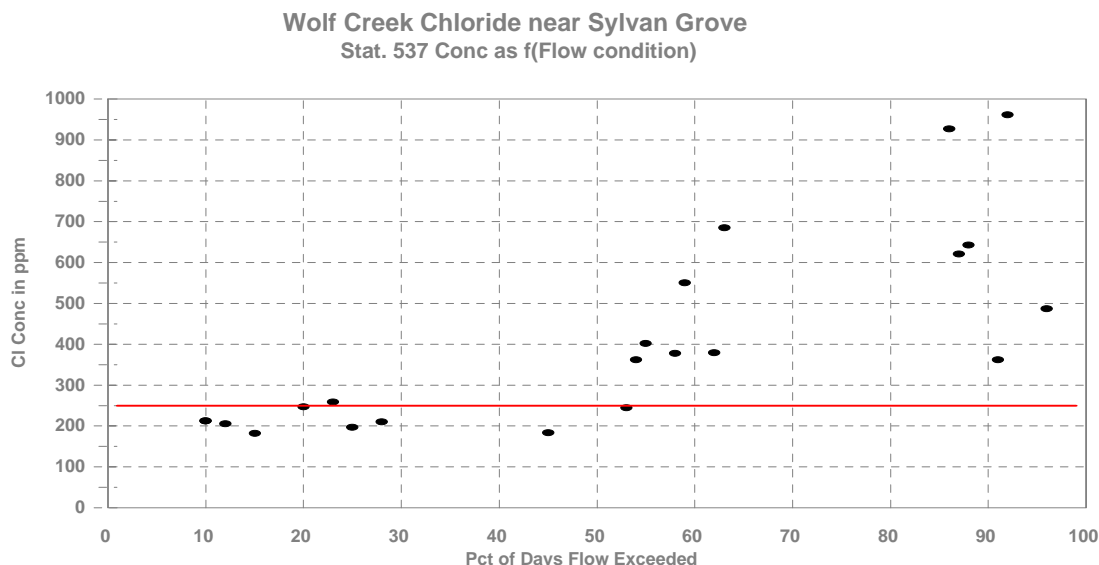


Table 2. Average Chloride Concentrations at USGS and KDHE stations in the Smoky Hill Basin

USGS Station	Average Chloride	KDHE Station	Average Chloride
Kansas R. - Ft.Riley	221 mg/l	Kansas R. - Ogden	194 mg/l
Pre-90 Smoky Hill R. - Enterprise	332 mg/l	Present Day Smoky Hill R. - Enterprise	347 mg/l
Saline R. - Tescott	416 mg/l	Saline R. - Beverly	387 mg/l

Because point source influences are most dramatic at low flows, the historic low flow condition seen on the Kansas River at Ft. Riley were identified from the period since 1990. Two periods of low flow appear (Figure 11); the droughts of 1991-1992 and 2002 – 2003. Endpoints for this TMDL were established at varying flows on the Kansas River at Ft. Riley. The TMDL focuses upon conditions at Ft. Riley/Ogden because the major point source of the system is located immediately upstream in Junction City, because the Kansas River is the domestic water supply for much of the population in Eastern Kansas and because the river is designated to support Special Aquatic Life. The only point of diversion for water supply is at Salina. There are no points of diversion to apply the 250 mg/l criterion downstream of Salina to Ogden.

Since loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired loads over all flow conditions, rather than fixed at a single value. Sample data for the sampling sites were examined for each of the three defined seasons: Spring (Apr-Jun), Summer-Fall (Jul-Oct) and Winter (Nov-Mar). Generally, exceedances were seen during the lower flows of Summer, Fall and Winter. High flows and runoff equate to lower flow durations; baseflow and point source influences generally occur in the 75-99% range. A Load curve was established for the Domestic Water Supply criterion by multiplying the flow values along the curve by the applicable water quality criterion and converting the units to derive a load duration curve of tons of chloride per day. These load curves represent the TMDL since any point along the curve represents water quality for the standard at that

Figure 11. Contemporary Monthly Flows on Kansas River at Fort Riley



Since the existing criterion is not achievable on the Saline River, the Smoky Hill River below Salina, the Upper Kansas River above Ogden and Wolf Creek, because of natural contributions of the chloride load, an alternative endpoint is needed. The need for an alternative endpoint is also justified by the inapplicability of the existing water quality standard for water supply since there are no points of diversion for domestic water supply between Salina and Ogden.

Kansas Implementation Procedures for Surface Water allow for a numerical criterion based on natural background to be established from samples taken at flows less than median in-stream flow. The specific stream criteria to supplant the general standard will be developed concurrent with Phase One of this TMDL following the appropriate administrative and technical Water Quality Standards processes. The initial endpoints are established on the Kansas River at Ogden and then calculated progressively upstream to account for likely contributions from point and non-point sources. The endpoints vary with flow conditions and thus the background concentrations are established at four exceedance percentiles: 1) 99%, which coincides with flow conditions during May 1992; 2) 90% flow and; 3) 75% flow, which reflect low flow conditions seen in 1991-1992 and 2001-2003, respectively; and; 4) median or 50% flow (Table 3). Corresponding TMDL curves were drawn by interpolation between the four endpoints.

Phase Two of the TMDL will be based on the future standard under these flow conditions within the watersheds draining to these KDHE Stations. The Phase One endpoint of 250 mg/l will be established at any points of diversion constructed for water supply along the streams of the watershed above Ogden.

Seasonal variation has been incorporated in this TMDL through the documentation of the seasonal consistency of elevated chloride levels. Achievement of the endpoints indicate loads are within the loading capacity of the stream, water quality standards are attained and full support of the designated uses of the stream has been restored.

Table 3. Background Concentration Endpoints for Applicable Stations in the Smoky Hill-Saline River System

Station	Background Conc. @ 99% Flow	Background Conc. @ 90% Flow	Background Conc. @ 75% Flow	Background Conc. @ 50% Flow
Kansas River at Ogden (Station 518)	475 mg/l	310 mg/l	265 mg/l	175 mg/l
Smoky Hill River at Enterprise (Station 265)	780 mg/l	510 mg/l	425 mg/l	265 mg/l
Saline River near New Cambria (Station 267)	555 mg/l	445 mg/l	335 mg/l	300 mg/l
Saline River near Beverly (Station 513)	625 mg/l	500 mg/l	400 mg/l	370 mg/l
Wolf Creek near Sylvan Grove (Station 537)	950 mg/l	750 mg/l	580 mg/l	390 mg/l

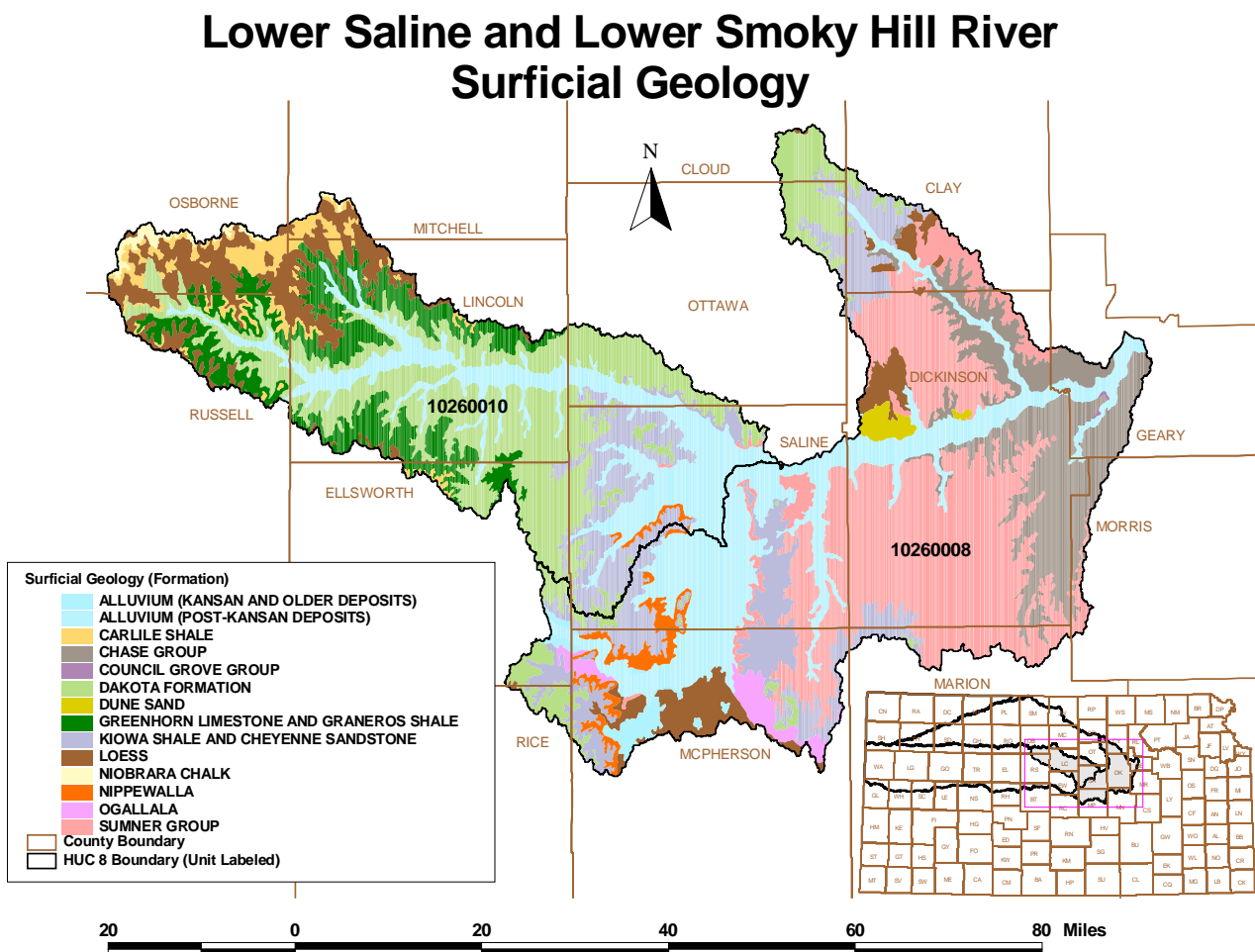
3. SOURCE INVENTORY AND ASSESSMENT

Geology: The main contribution of chloride to the Lower Smoky Hill – Saline River system is geologic formations at two locations within the sub-basin. The first is the discharge of natural saltwater from the Dakota aquifer into the alluvial aquifer and then the river, particularly along the Saline River and Wolf Creek (Figure 12). The saltwater in the Dakota comes from rock salt dissolution in underlying Permian strata, such as the Cedar Hills Sandstone, in Russell County. The Saline River tends to have substantially more chloride loading than the Smoky Hill River, including loads within the releases of Wilson Dam. USGS data collected from 1964-1970 on the Saline River below the dam averaged 1030 mg/l of chloride. The same geologic source (the Cedar Hills formation via the Dakota aquifer) discharges chloride to the Saline River above the dam in Russell County. Interaction with fresh water aquifers in the lower reaches of the Saline River in Lincoln and Saline Counties dilutes the chloride concentrations in the stream. These localized fresh water supplies also cause lower chloride levels in Mulberry Creek and the Smoky Hill River between Salina and Mentor.

The second location of mineral intrusion is in eastern Saline County and western Dickinson County where ground water discharges from the Permian Wellington Formation into the alluvium of the Smoky Hill River as well as the lowest reach of the Solomon River. This saltwater is derived from dissolution of halite deposits within the Hutchinson Salt Member of the Wellington Formation. This intrusion tends to be substantially higher in chloride than the western intrusion area. Gillespie and Hargadine (1981, 1986) found chloride levels approaching 50-70,000 mg/l in the alluvium of the rivers at the Saline-Dickinson county line. Median concentrations of base flow chloride discharge to the stream channel lie within the 900-1000 mg/l range near the Smoky Hill – Solomon River confluence.

Small amounts of chloride within bedrock minerals and traces of seawater trapped in the marine bedrock that are released during weathering will contribute minor amounts of chloride load. Evapo-transpiration and consumptive use of water in the basin can increase chloride levels in the streams.

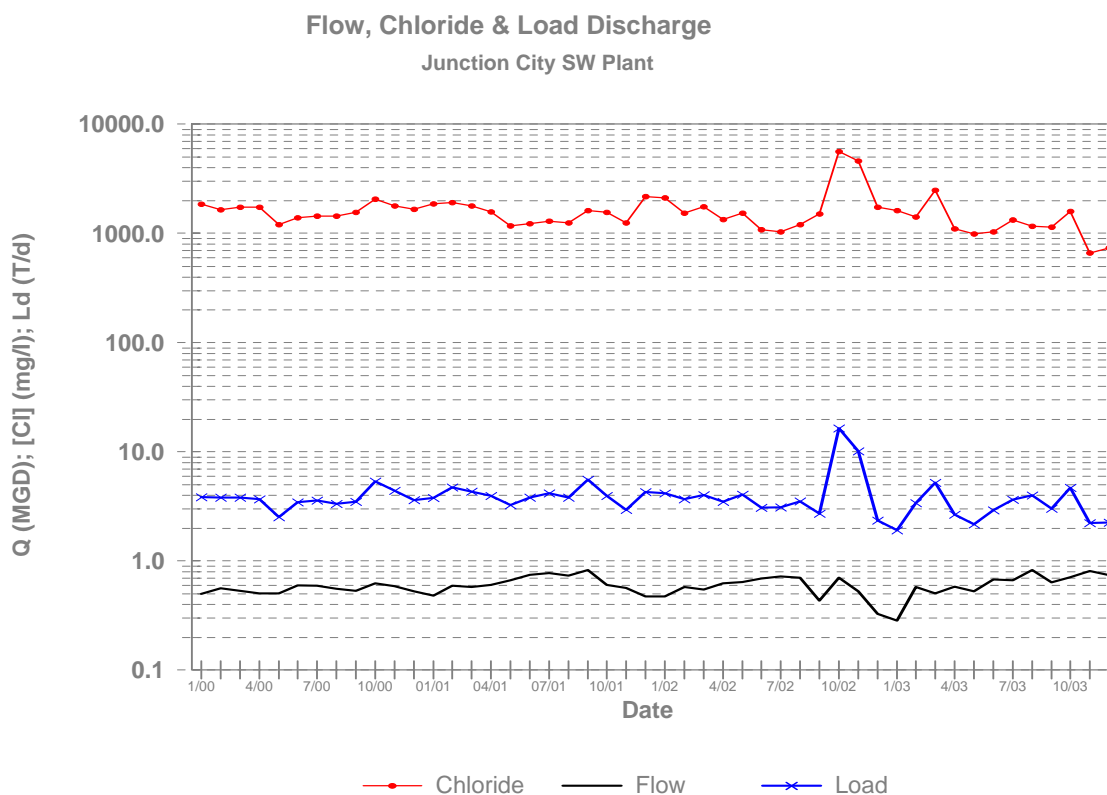
Figure 12. Surface Geology of TMDL Area



NPDES: There are fifteen permitted wastewater treatment facilities discharging to the Smoky Hill, Saline or Kansas Rivers (Appendix A-1). These fifteen point sources are listed in Appendix A-2 and typically discharge minor amounts of chloride to the rivers, with one exception. The Southwest Facility at Junction City currently takes wastewater from a food processing plant and discharges a high chloride load to the Smoky Hill River. Tracking the average monthly discharge of chloride over 2000-2003 shows a slight decline in concentration and load in recent months from the plant (Figure 13).

There are also four additional dischargers to the Smoky Hill River above the Mentor monitoring station (Appendix A-3). Since the river is not impaired by chloride between Kanopolis Dam and Salina, these point sources are accounted by the ambient monitoring at Mentor and will not be assigned wasteload allocations under this TMDL. Similarly, there are eight dischargers on tributaries to the Smoky Hill and Saline Rivers that are accounted by monitoring stations located near the outlet of the tributary watersheds (Appendix A-4). The monitoring data indicate these tributaries are not impaired by chloride, except Wolf Creek. Finally, there are eight quarries with NPDES permits located with the TMDL area (Appendix A-5). Six of the quarries handle limestone, one is a clay mining operation and the last site

Figure 13. Effluent Characteristics for Junction City Southwest Wastewater Plant (2000-03)



quarries shale. Review of the discharge records for the quarries indicates all but one does not discharge except for quarry or mine pit dewatering or during stormwater runoff. The one quarry located in Geary County does discharge regularly, but does not monitor for chlorides. Since it is a limestone quarry, it is unlikely to discharge any chlorides into the Smoky Hill River and any load it does discharge will be dwarfed by the flow volume and chloride concentrations seen in the Smoky Hill River.

There are also twenty-eight non-discharging municipal, commercial and industrial facilities within the TMDL area (Appendix B). These facilities retain all wastewater and will be given a wasteload allocation of zero to reflect their lack of discharge and impact to the streams of the Lower Smoky Hill, Lower Saline and Upper Kansas sub-basins.

Irrigation: Use of surface and ground water for irrigation does occur throughout the sub-basins, but in moderate volumes. Table 4 displays the 2001 reported Irrigation Water Use and estimates of potential stream depletion and return flows for the monitored watersheds in the three sub-basins. Potential depletion was estimated by assuming the total irrigation use, from both surface water and ground water, was supplied by the streams in each watershed over the course of an 120-day growing season. Return flows were estimated by assuming that 85% of the diversion was consumed through evapotranspiration and deep percolation would return the remaining water to the stream as seepage over an 180-day period. By these calculations, ten percent of the diverted water would be returned to the stream.

Table 4. 2001 Irrigation Use in Sub-basins of the Lower Smoky Hill – Saline River System

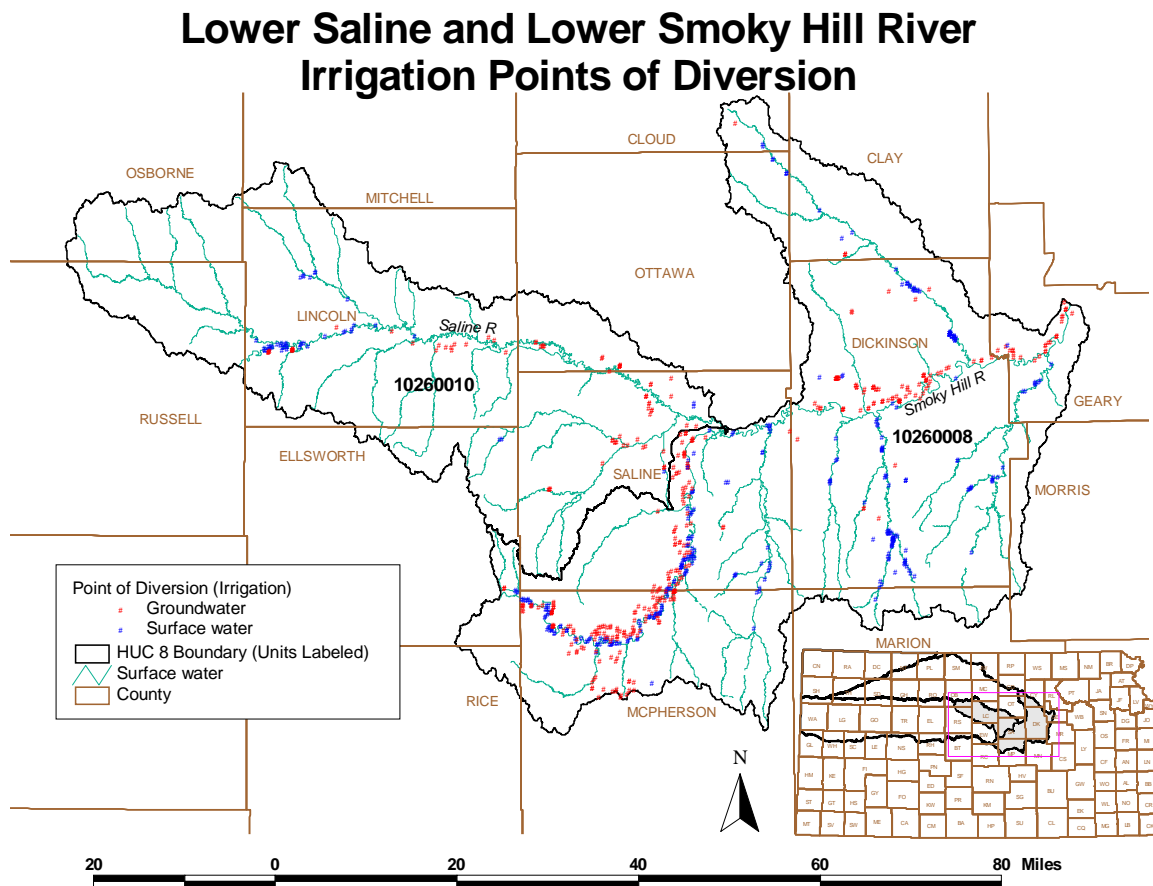
Monitoring Site	Site #	SW af	GW af	Total af	Pot. Depletion	Pot. Return Flows
Saline-Beverly	513	206.4	529.5	735.9	3.1 cfs	0.31 cfs
Saline-New Cambria	267	0	305.6	305.6	1.3 cfs	0.13 cfs
Wolf Creek	537	0	0	0	0	0
Bullfoot Creek	671	0	0	0	0	0
Elkhorn Creek	672	0	0	0	0	0
Spillman Creek	673	0	0	0	0	0
Mulberry Creek	640	1.0	299.3	299.3	1.3 cfs	0.13 cfs
Smoky Hill – Mentor	514	2552.3	6147.4	8699.7	36.6 cfs	3.7 cfs
Smoky Hill – Salina	268	64.6	1386.8	1451.4	6.1 cfs	0.6 cfs
Smoky Hill –Enterprise	265	0	919.8	919.8	3.9 cfs	0.39 cfs
Gypsum Creek	641	63.2	18.8	82.0	0.34 cfs	0.03 cfs
Holland Creek	642	0	0	0	0	0
Mud Creek	643	0	432.8	432.8	1.82 cfs	0.18 cfs
Turkey Creek	644	188.1	9.2	197.3	0.83 cfs	0.08 cfs
Kansas – Ogden	518	0	2471.4	2741.4	10.4 cfs	1.0 cfs
Lyon Creek	516	84.7	0	84.7	0.36 cfs	0.04 cfs
Chapman Creek	515	537.5	32.3	569.8	2.4 cfs	0.24 cfs

As can be seen in Table 4 and Figure 14, most of the irrigation is located within the alluvial valley of the Smoky Hill River between Kanopolis Dam and Salina. Additional irrigation pressure is seen along the Smoky Hill and Kansas Rivers between Enterprise and Ogden. These two irrigation areas coincide with areas with the freshest water supply. Within the saline influenced drainages of the Saline River from Wilson Dam to Salina and the Smoky Hill River from Salina to Enterprise, irrigation is spottier because of the poor quality water, particularly in the area influenced by the briny Wellington formation.

Irrigation along the tributaries is very small, because of the lower availability of water and the diminished suitability of the soils and landscape for irrigation.

Irrigation along the Smoky Hill River from Kanopolis Dam to Salina is seasonally intense with loss of flow between the Langley gage to the Mentor gage. Any loss of flow is reversed once growing season ceases. The depletion impact is mitigated, to a degree, by releases from Kanopolis and, despite, the heaviest irrigation pressure, there are no chloride impairments at the Mentor or Salina monitoring sites. Given the strong environmental constraint of the saline water supplies, irrigation does not exert much influence on the chloride levels seen in the TMDL area. Irrigation is either non-existent, of small volume in terms of depletion and return flows, or mitigated by reservoir releases, particularly from Kanopolis and Milford Reservoir on the Republican above Junction City. The lack of any trend over time in comparing historic USGS chloride data with current monitoring data tends to confirm that, in this system, irrigation impacts are localized and not exerting influence on the chloride levels seen on the Smoky Hill, Saline or Kansas Rivers.

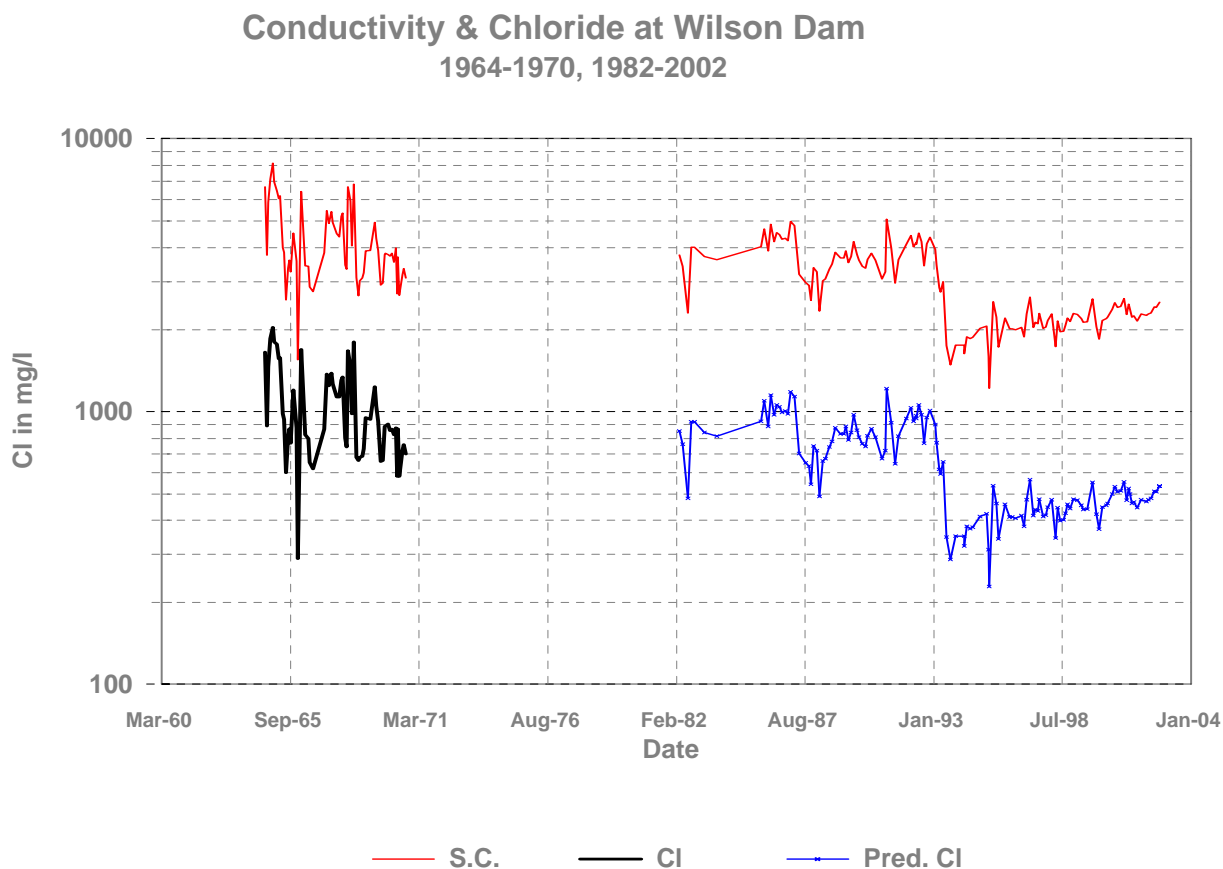
Figure 14. Irrigation Points of Diversion in Lower Saline and Smoky Hill Subbasins



Brine from Oil and Gas Operations: While there are some historic oil and gas operations (see www.kgs.ku.edu/PRS/petro/interactive.html) within the TMDL area, examination of the chemistry of the water in Wolf Creek, Saline River and Smoky Hill River indicates that any loading from brine disposal, past or present, is insignificant in the face of the climatic and geologic variability of chloride levels seen in the streams (Whittemore, 2004).

Wilson Dam Releases: Chloride samples were taken by USGS at the gaging station below Wilson Dam from 1964 to 1970 and specific conductivity measurements were taken from 1964 to 2002. There is a strong correlation between conductivity and chloride ($Cl = 0.056 \cdot SC^{(1.17)}$; $R^2 = 0.991$). Figure 15 shows the variability of conductivity and predicted chloride over time. There was a data gap between 1970 and 1982. The highest chlorides were present within Wilson Lake in 1964-1965, when the lake was filling and minimal releases of water were made. As the pool filled, usually by sporadic fresh water runoff, chloride levels declined in 1970. Resumption of sampling in 1982 saw chloride levels elevated slightly from 1970, likely an aftermath of the 1980-81 drought conditions. A major filling event in 1987 depressed chloride levels and the 1993 flood significantly diluted the lake concentrations. Since 1993, the lake drainage has been getting dryer over time and chlorides are trending upward. Average of actual chloride concentrations in 1964-1970 was 1030 mg/l. Average predicted chloride from 1982 to 2002 was 640 mg/l. Average estimated chloride during the critical low flow of early 1992 was 980 mg/l. Releases from Wilson Lake reflecting capture of Dakota mineralized intrusion into the Saline River have a significant influence on downstream chloride concentrations.

Figure 15. Actual and Estimated Chloride Concentration of Wilson Dam Releases



4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

Point and Non-point Sources: Mass balance analysis was used to allocate the chloride loading in the Smoky Hill River System delineated by the Mentor monitoring station on the Smoky Hill River, Wilson

Dam on the Saline River and the Ogden monitoring station on the Kansas River. Loadings were evaluated at the four flow conditions of 99%, 90%, 75% and 50% exceedance flows. Calibration of tributary flows, background concentrations and point source loadings were established at the 99% exceedance flows, indicated at May 1992 conditions. After endpoints were established at Ogden, the upstream loadings necessary to achieve the Ogden endpoints were calculated. After the 1992 conditions were established, point source loadings were increased to reflect current and design flow contributions and allowed to accumulate downstream to establish revised Ogden conditions.

Much of the impaired conditions are caused by natural background loadings, therefore point source controls are not emphasized greatly, with one exception. The mass balance calculations were segregated by monitored segments: 1) the Upper Kansas River from Enterprise to Ogden; 2) the Lower Smoky Hill River from Enterprise to New Cambria; 3) the Smoky Hill River from New Cambria to Mentor and the Saline River from New Cambria to Beverly; 4) the Saline River from Beverly to Wilson Dam; and 5) Wolf Creek. Mass balance tables for design wastewater flows and 99% exceedance flows are attached in Appendices C-F. Table 5 displays the total loads, wasteloads and load allocations that will be in place under Phase Two for the four stream sub-systems. Under Phase One, Table 5 would have the Wasteload Allocations altered in order to comply with the existing water quality criterion of 250 mg/l. Should a domestic water supply point of diversion become established within the TMDL area, the Phase One criterion and Wasteload Allocations influencing water quality in that river reach would be applied to ensure the water supply use was protected.

Table 5. Phase Two Loads and Allocations (tons/day) for Smoky Hill – Saline River System
Flow Exceedance Frequency

Stream Sub-System	99%	99%	90%	90%	75%	75%	50%	50%
Upper Kansas River at Ogden TMDL	212	----	282	----	409	----	587	----
Wasteload Allocations	----	10.7	----	10.7	----	10.7	----	10.7
Tributary and Alluvial Load Allocations	----	3.4	----	5.5	----	14.2	----	24.0
Republican River Load Allocation	----	3.2	----	7.6	----	11.6	----	29.0
Smoky Hill River at Enterprise TMDL	195	----	258	----	373	----	523	----
Wasteload Allocations	----	1	----	1	----	1	----	1
Tributary and Alluvial Load Allocations	----	120	----	131	----	203	----	214
Solomon River at Niles TMDL	34	----	53	----	77	----	151	----
Smoky Hill River at New Cambria TMDL	40	----	73	----	92	----	157	----
Wasteload Allocations	----	8	----	8	----	8	----	8
Tributary and Alluvial Load Allocations	----	(-8)	----	(-1)	----	10	----	12
Smoky Hill River at Mentor TMDL	11	----	29	----	34	----	62	----
Saline River at New Cambria TMDL	29	----	37	----	41	----	76	----
Wasteload Allocations	----	0.1	----	0.1	----	0.1	----	0.1
Tributary and Alluvial Load Allocations	----	1.7	----	3.3	----	3.8	----	6
Saline River at Beverly TMDL	27	----	34	----	37	----	70	----
Wasteload Allocations	----	0.4	----	0.4	----	0.4	----	0.4
Tributary and Alluvial Load Allocations	----	6.5	----	10	----	6	----	13
Wolf Creek near Sylvan Grove TMDL	1.3		1.4		3.8		5.9	
Wasteload Allocations		0.1		0.1		0.1		0.1
Tributary and Alluvial Load Allocations		1.2		1.3		3.7		5.8
Saline River at Wilson Dam TMDL	19	----	22	----	26	----	50	----

There are three remarkable findings among the loadings in Table 5. First, the majority (56%) of loading at low flow is contributed by the intervening flow along the Smoky Hill River between New Cambria and Enterprise. This contribution coincides with the major mineral intrusion area between New Cambria and the confluence of the Solomon and Smoky Hill River, where upwelling ground water from the Wellington Formation and the Hutchinson Salt Member loads large amounts of chloride into the Smoky Hill River. The Solomon and Saline Rivers also contribute substantial chloride loads into the river system above Enterprise and Ogden.

Second, there is a loss of load along the Smoky Hill River between Mentor and New Cambria caused by loss of streamflow in that reach. There is a strong irrigation presence above and below Mentor and the loss of water during the growing season is regularly seen between the USGS gages at Langley and Mentor. Since chloride is conservative and in a dissolved state, as the water is lost to the surrounding alluvium, the associated chloride load is lost as well before the confluence of the Smoky Hill River with the Saline River.

Third, the largest point source contributions occur between Enterprise and Ogden, and a majority of that loading is associated with the Southwest Treatment Plant of Junction City that receives a high chloride loading from meat processing industries within the city. The average chloride concentration in the effluent from the Southwest Plant is 1630 mg/l since 2000, although daily maximum concentrations average 2700 mg/l, exceeding 10,000 mg/l on two occasions. The next largest wasteload comes from Salina that discharges a relatively low (260 mg/l) chloride concentration in its effluent, but, at design flow, contributes over 11.2 cfs (7.25 MGD).

A variety of scenarios involving the point source dischargers were examined in relation to chloride concentrations and loads on the Smoky Hill, Republican and Kansas Rivers. Table 6 shows the resulting values for each of the scenarios. The first scenario calibrated loadings to May 1992 conditions. The second scenario increased the wasteloads to present-day (2004) values. The third scenario evaluated increased loads to design flow conditions at each of the facilities.

The fourth scenario eliminated all wasteloads, this scenario reflects ambient stream conditions without point source influences, the natural background condition. The fifth scenario reflected the Phase One endpoint by imposing a 250 mg/l limit on all point sources. The sixth scenario also set effluent limits at 250 mg/l, but held those facilities, currently discharging less than 250 mg/l, to maintain their current levels. The seventh scenario set the 250 limit at the Junction City Southwest plant, but allowed all facilities to continue their current level of chloride discharge. The eighth scenario reflects the Phase Two endpoint allowing the Southwest plant to discharge at levels comparable to natural background. All other plants are discharging at current concentrations.

The resulting concentrations and loads at Ogden between Phase One and Phase Two do not differ significantly. This is because, under Phase One, all facilities discharge at 250 mg/l. For some facilities, actual discharges are less than their allocation at 250 mg/l. By trading that excess capacity to the Southwest Plant, a higher allocation may be given that discharge with little change in the stream conditions.

Table 6. Resulting Chloride Concentrations and Loads from Various Point Source Loadings at Junction City

Scenario	1	2	3	4	5	6	7	8	9
	1992 Loads	2004 Loads	Design Loads	0 WLA	TMDL Phase 1	< 250	SW 250	TMDL Phase 2	TMDL 2 w/ New Ft. Riley Plant
Ogden Cl (ppm)	476	483	485	502	460	452	454	462	464
Ogden Load (t/d)	200	204	223	192	211	207	208	212	212
Smoky Cl	586	594	600	614	561	558	560	571	571
Smoky Load	195	199	216	189	202	201	202	206	206
Repub Cl	52	52	56	43	74	56	71	56	54
Repub Load	4.3	4.3	5.0	3.3	6.5	5.0	6.3	5.0	4.6

In the last scenario, Fort Riley is reportedly constructing a 2.35 MGD plant located by the Custer Hill site to replace its three existing facilities. At the presumed 150 mg/l effluent concentration, this change would reduce the Wasteload Allocation of Ft. Riley to 1.47 t/d, decrease the chloride concentration in the Republican River by 2 mg/l, raise the concentration at Ogden by 2 mg/l, and hold the total load of chloride at Ogden at 212 tons per day.

The Wasteload Allocation for this TMDL establishes an effective limit below the background concentration and the aquatic life acute criterion on the Southwest Plant and holds the other facilities to their typical current levels. Reduction of the Southwest plant effluent concentration along with maintaining design flow discharges of low chloride wastewater lowers the overall concentration and load in the Smoky Hill and Kansas Rivers, maintains the low concentrations in the Republican River and minimizes any zones of acute chloride toxicity below the Southwest outfall. Concentrations are generally lower than those seen in 1992, but loads are increased because of the increased volume of wastewater discharged to the streams. Table 7 displays the individual wasteload allocations for point sources discharging to the Saline, Smoky Hill and Kansas Rivers under Phases One and Two. Phase One allocations will only be utilized if water supply points of diversion are established below the outfalls of these facilities. After the construction of the new Fort Riley plant, the Total Wasteload Allocations for Phases One and Two will be within three percent of one another.

Discharger	Ft. Riley New WWTP	Ft.Riley- Custer Hill*	Ft. Riley- Main Post*	Ft.Riley- Camp Forsyth*	Junction City – East	Junction City – SW	Grandview Plaza	Chapman	Enterprise
Phase One WLA (tons/day)	2.46	1.39	1.15	0.66	2.61	2.61	0.20	0.26	0.09
Phase Two WLA	1.47	0.83	0.69	0.39	1.36	6.53	0.32	0.42	0.15
Discharger	Abilene WTF	Abilene WWTP	VB Interim	Solomon	Scouler Elevator	Salina	Tescott	Beverly	Lincoln Center
Phase One WLA (tons/day)	0.30	1.32	0.42	0.11	0.04	7.57	0.01	0.07	0.23
Phase Two WLA	0.10	0.58	0.17	0.18	0.05	7.87	0.02	0.08	0.37

* Plant will be replaced by new plant at Ft. Riley

Table 7. Chloride Wasteload Allocations for Dischargers to Lower Smoky-Upper Kansas River System

Wolf Creek located north of Wilson Lake and above Sylvan Grove is also listed as impaired for chloride. The Phase One Wasteload Allocation for the Lucas facility discharging into Wolf Creek is 0.088 tons per day based on the design flow and the Phase Two Wasteload Allocation rises to 0.142 tons/day with an assumed effluent concentration of 400 mg/l.

Figures 16 through 20 show the load duration curves for Ogden, Enterprise, New Cambria, Beverly and Wolf Creek. Since the concentrations and loads vary with flow, the curves were established at the endpoints designated at the 99%, 90%, 75% and 50% exceedance flows and the loads occurring between those flow conditions were interpolated, allowing for a smoothing of the load curves. As indicated by the curves, a majority of the load is contributed by the load allocations, which coincide with the Dakota Formation ground water in the Saline River watershed below Wilson Dam and the Wellington Formation along the Smoky Hill River east of Salina.

Margin of Safety: The Margin of Safety is implicitly established by holding point sources to concentrations below background levels. Since the elevated chloride levels seen in the streams are predominantly caused by the natural loadings of saline groundwater from underlying geologic formations, the only mitigating factor to those load allocations is the dilution provided by the point sources. By not allowing the wasteload allocations to be established by the background concentrations, the dilution base is secured and the Phase Two endpoints will be achieved.

State Water Plan Implementation Priority: Because the chloride impairment along the Lower Saline and Smoky Hill Rivers is primarily due to natural geologic sources, this TMDL will be a Low Priority for implementation.

Figure 16. Kansas River at Ogden Chloride TMDL

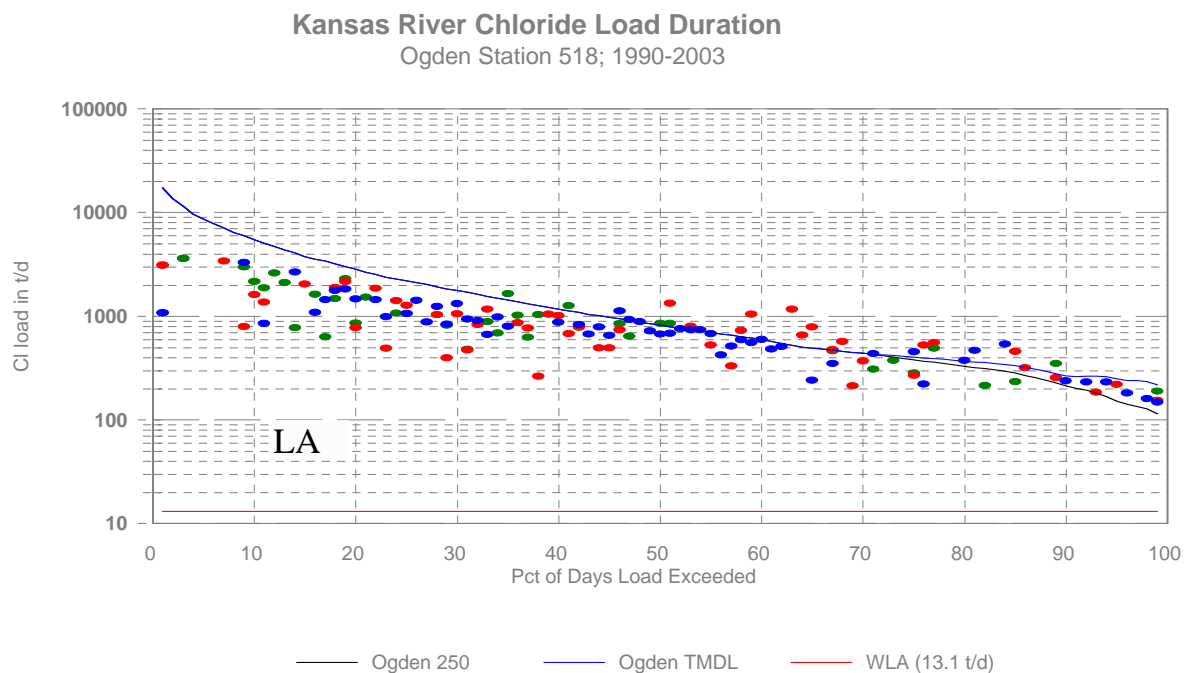


Figure 17. Smoky Hill River at Enterprise Chloride TMDL

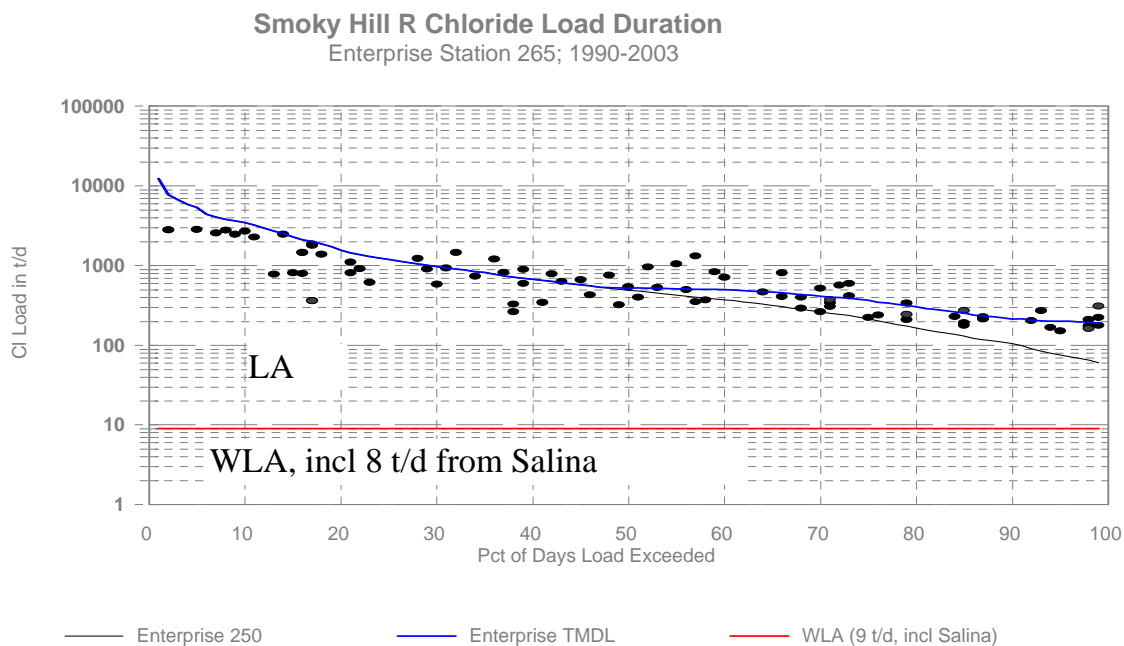


Figure 18. Saline River at New Cambria Chloride TMDL

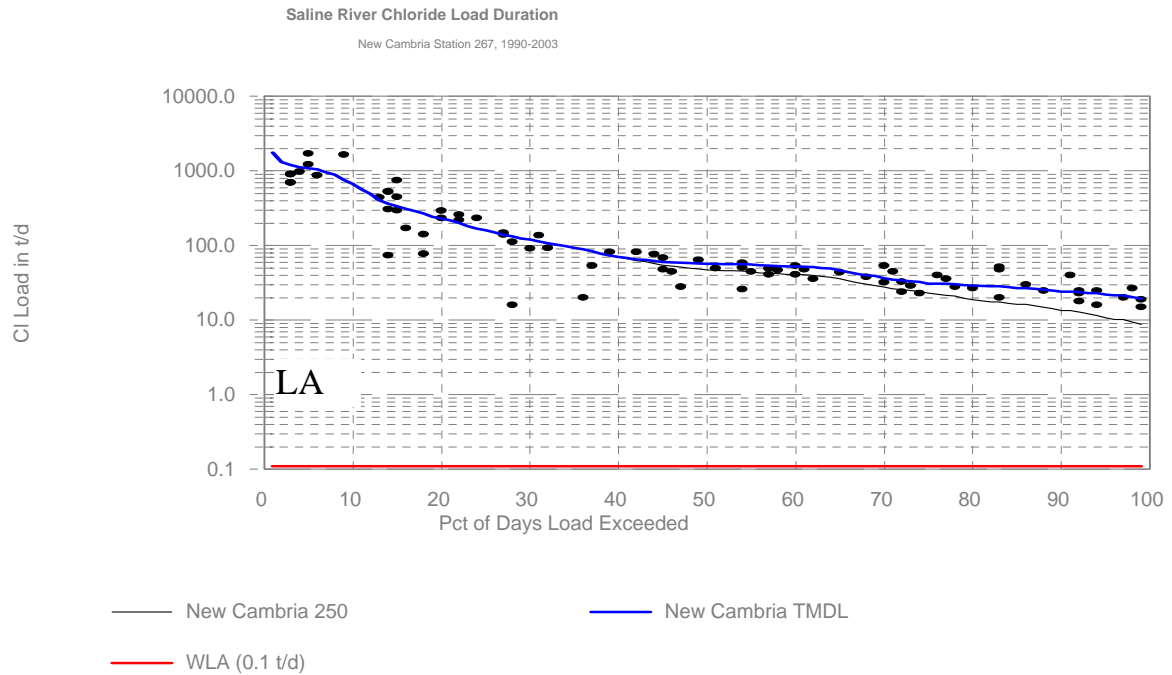


Figure 19. Saline River at Beverly Chloride TMDL

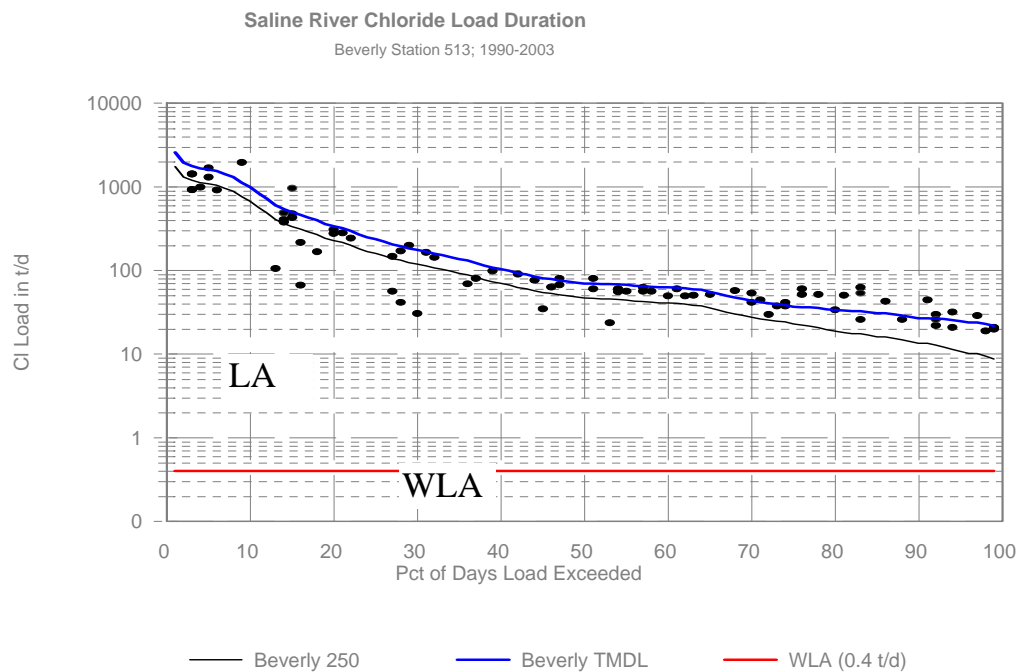
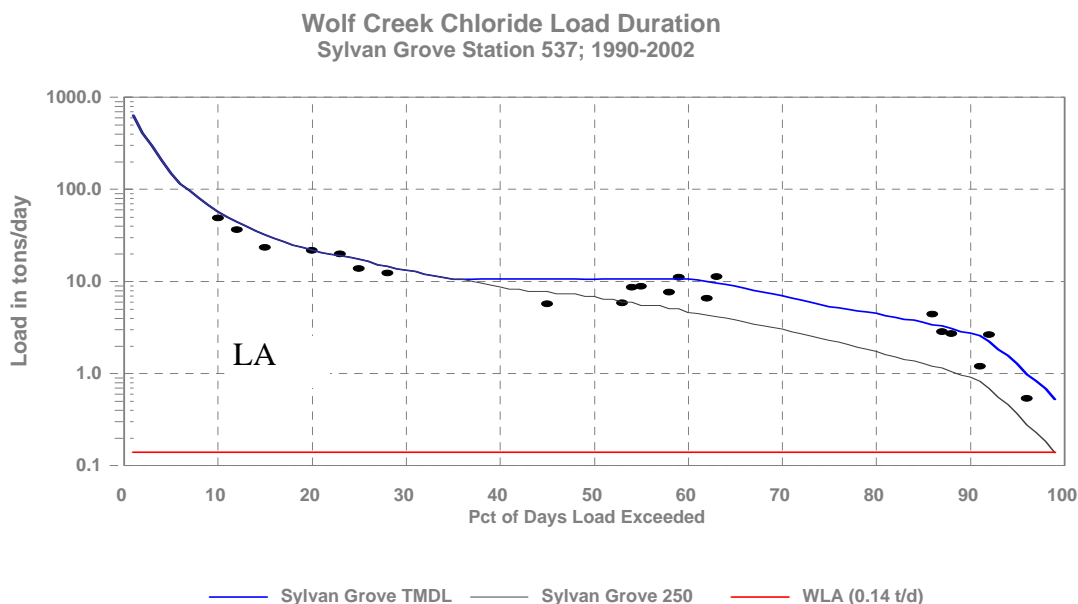


Figure 20. Wolf Creek near Sylvan Grove Chloride TMDL



Unified Watershed Assessment Priority Ranking: This TMDL addresses streams within three Subbasins: the Lower Smoky Hill (HUC 8: 10260008) with a ranking of 35 (Medium Priority for restoration), the Lower Saline (HUC 8: 10260010) with a ranking of 33 (Medium Priority for restoration) and the Upper Kansas (HUC 8: 10260101) with a priority ranking of 22 (Medium Priority for restoration).

Priority HUC 11s: Because of the natural geologic contribution of this impairment, no priority subwatersheds or stream segments will be identified.

5. IMPLEMENTATION

Desired Implementation Activities

1. Monitor any anthropogenic contributions of chloride loading to the river system.
2. Establish alternative background criterion.
3. Reduce any high chloride industrial waste streams through process modification

Implementation Programs Guidance

NPDES and State Permits - KDHE

- a. Municipal, industrial and Federal permits for facilities in the watershed will be renewed after 2004 with annual chloride monitoring and any facility with excessive chloride discharge will have appropriate permit limits which maintain the ambient background levels of chloride. Extremely high chloride dischargers will be limited to acute concentrations via permit limits.

Non-Point Source Pollution Technical Assistance - KDHE

- a. Evaluate any potential anthropogenic activities which might contribute chloride to the streams as part of an overall Watershed Restoration and Protection Strategy.

Water Quality Standards and Assessment - KDHE

- a. Establish background levels of chloride for the river and tributaries.

Pollution Prevention Institute – Kansas State University

- a. Work with Junction City and meat processing industries on process improvements to reduce the waste stream of high chloride water entering municipal wastewater treatment system.

Time Frame for Implementation: Development of a background level-based water quality standard should be accomplished with the 2004 water quality standards revision.

Targeted Participants: Primary participants for implementation will be KDHE.

Milestone for 2009: The year 2009 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, sampled data from the streams covered by this TMDL should indicate no increase in average chloride levels in the streams, particularly at lower flows. Should the case of impairment remain, additional source assessment, allocation and implementation activities will ensue.

Delivery Agents: The primary delivery agents for program participation will be the Kansas Department of Health and Environment.

Reasonable Assurances:

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollutants.

1. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.
2. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.
3. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control nonpoint source pollution.
4. K.S.A. 82a-901, et seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.
5. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan*.
6. The *Kansas Water Plan* and the Smoky Hill/Saline Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund annually generates \$16-18 million and is the primary funding mechanism for implementing water quality protection and pollutant reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are a Low Priority consideration.

Effectiveness: Minimal control can be exerted on natural contributions to loading, although dilution from reservoir releases are effective in lowering chloride concentrations to downstream reaches. Interception of the saline ground water and subsequent deep injection may be effective in lowering chloride over the long term.

6. MONITORING

KDHE will continue to collect bimonthly samples from permanent and rotational stations between Kanopolis and Wilson Dams and the Kansas River at Ogden. Based on that sampling, the priority status will be evaluated in 2009 including application of numeric criterion based on background concentrations.

Annual monitoring of chloride levels in effluent will be a condition of NPDES and state permits for facilities. This monitoring will continually assess the contributions of chloride in the wastewater effluent released to the streams upstream of Ogden.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Smoky Hill/Saline Basin were held January 7 and March 5, 2003 in Hays. An active Internet Web site was established at <http://www.kdhe.state.ks.us/tmdl/> to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Smoky Hill/Saline Basin.

Public Hearing: A Public Hearing on the TMDLs of the Smoky Hill/Saline Basin was held in Hays on June 2, 2003.

Basin Advisory Committee: The Smoky Hill/Saline Basin Advisory Committee met to discuss the TMDLs in the basin on October 3, 2002, January 7, March 5, and June 2, 2003.

Discussion with Interest Groups: Meetings to discuss TMDLs with interest groups include:
Smoky Hill River Task Force: January 22, February 27, April 16, and May 28, 2003

Milestone Evaluation: In 2009, evaluation will be made as to the degree of implementation which has occurred within the watershed and current condition of the streams of the Lower Smoky Hill, Lower Saline and Upper Kansas Sub-basins. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

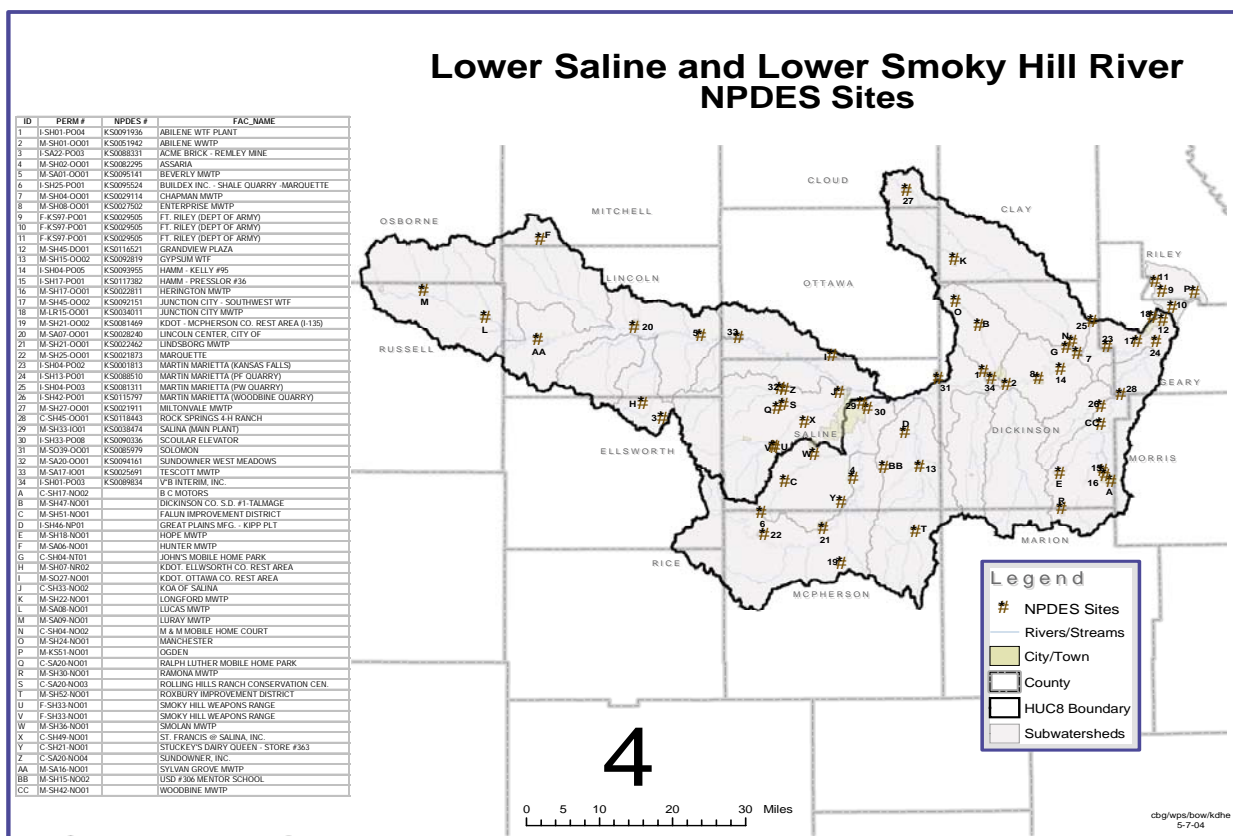
Consideration for 303(d) Delisting: The streams will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2008-2012. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2005 which will emphasize revision of the Water Quality Management Plan. At that time, incorporation of this TMDL will be made into both documents. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2004-2008.

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2. Gillespie, J.B. and G.D.Hargadine; 1981; Saline Ground-Water Discharge to the Smoky Hill River Between Salina and Abilene, Central Kansas; U.S. Geological Survey Water Resources Investigations Report 81-43; 71 p.
3. Gillespie, J.B. and G.D. Hargadine; 1986; Geohydrology of the Wellington-Alluvial Aquifer System and Evaluation of Possible Locations of Relief Wells to Decrease Saline Ground-Water Discharge to the Smoky Hill and Solomon Rivers, Central Kansas; U.S. Geological Survey Water Resources Investigations Report 86-4110; 31 p.

Appendix A-1 NPDES Sites in Smoky Hill TMDL Area



APPENDIX A-2: DISCHARGERS OF CHLORIDE INTO SMOKY HILL, SALINE AND KANSAS RIVERS

PERMIT #	NPDES #	FACILITY NAME	RECEIVING STREAM	DSGN Q (MGD)	AVG CL (mg/l)
F-KS97-PO01	KS0029505	FT. RILEY (CUSTER HILL)	KANSAS RIVER VIA THREE MILE CREEK	1.330	150*
F-KS97-PO01	KS0029505	FT. RILEY (MAIN POST)	KANSAS RIVER	1.100	150*
F-KS97-PO01	KS0029505	FT. RILEY (CAMP FORSYTH)	KANSAS RIVER VIA REPUBLICAN RIVER	0.630	150*
M-LR15-OO01	KS0034011	JUNCTION CITY MWTP	KANSAS RIVER VIA REPUBLICAN RIVER	2.500	130
M-SH45-DO01	KS0116521	GRANDVIEW PLAZA	SMOKY HILL RIVER	0.190	400*
M-SH45-OO02	KS0092151	JUNCTION CITY - SOUTHWEST WTF	SMOKY HILL RIVER	2.500	1630
M-SH04-OO01	KS0029114	CHAPMAN MWTP	SMOKY HILL RIVER	0.250	380
M-SH08-OO01	KS0027502	ENTERPRISE MWTP	SMOKY HILL RIVER	0.090	400
M-SH01-OO01	KS0051942	ABILENE WWTP	SMOKY HILL RIVER	1.206	110
M-SO39-OO01	KS0085979	SOLOMON MWTP	SMOKY HILL RIVER VIA SOLOMON RIVER	0.110	400*
M-SH33-IO01	KS0038474	SALINA (MAIN PLANT)	SMOKY HILL RIVER	7.250	260
I-SH33-PO08	KS0090336	SCOULAR ELEVATOR	SMOKY HILL RIVER VIA EAST DRY CREEK	0.036	300*
M-SA01-OO01	KS0095141	BEVERLY MWTP	SALINE RIVER	0.014	400*
M-SA17-IO01	KS0025691	TESCOTT MWTP	SALINE RIVER	0.048	400*
M-SA07-OO01	KS0028240	LINCOLN MWTP	SALINE RIVER	0.220	400*

* Chloride concentration of effluent estimated

APPENDIX A-3: DISCHARGERS TO THE SMOKY HILL RIVER ABOVE THE MENTOR STATION

PERMIT #	NPDES #	FACILITY NAME	RECEIVING STREAM	DES Q (MGD)
M-SH02-OO01	KS0082295	ASSARIA	SMOKY HILL RIVER	0.0600
M-SH21-OO01	KS0022462	LINDSBORG MWTP	SMOKY HILL RIVER	0.4180
M-SH21-OO02	KS0081469	KDOT - MCPHERSON CO. REST AREA (I-135)	SMOKY HILL RIVER VIA W. KENTUCKY CREEK	0.0076
M-SH25-OO01	KS0021873	MARQUETTE	SMOKY HILL RIVER	0.0670

APPENDIX A-4: DISCHARGERS TO MONITORED TRIBUTARIES TO THE SMOKY HILL AND SALINE RIVERS

PERMIT #	NPDES #	FACILITY NAME	RECEIVING STREAM	DES Q (MGD)	AVG CL (mg/l)
M-SH17-OO01	KS0022811	HERINGTON MWTP	SMOKY HILL R VIA LIME CR	0.9000	
C-SH45-OO01	KS0118443	ROCK SPRINGS 4-H RANCH	SMOKY HILL R VIA LYON CRK	0.0125	
I-SH01-PO03	KS0089834	V*B INTERIM, INC.	SMOKY HILL RIVER VIA MUD CREEK	0.4000	100*
I-SH01-PO04	KS0091936	ABILENE WTF PLANT	SMOKY HILL RIVER VIA MUD CREEK	0.2880	80
M-SH27-OO01	KS0021911	MILTONVALE MWTP	CHAPMAN CR	0.0490	
M-SH15-OO02	KS0092819	GYPSUM WTF	GYPSUM CREEK	0.0410	
M-SA20-OO01	KS0094161	SUNDOWNER WEST MEADOWS	MULBERRY CREEK	0.0110	
M-SA08-OO02	KS0095222	LUCAS MWTP	WOLF CREEK	0.0850	

APPENDIX A-5: QUARRY DISCHARGERS IN LOWER SMOKY HILL/SALINE BASIN

PERMIT #	NPDES #	FACILITY NAME	RECEIVING STREAM	TYPE	ACT Q?
I-SH04-PO02	KS0001813	MARTIN MARIETTA (KANSAS FALLS)	SMOKY HILL RIVER/OLD RIVER OXBOW	LIMESTN	YES
I-SH04-PO05	KS0093955	HAMM - KELLY #95	SMOKY HILL RIVER/TERRAPIN LAKE	LIMESTN	NO
I-SH17-PO01	KS0117382	HAMM - PRESSLOR #36	SMOKY HILL RIVER	LIMESTN	NO
I-SH42-PO01	KS0115797	MARTIN MARIETTA (WOODBINE QUARRY)	LWR SMOKY HILL R VIA LYON CR	LIMESTN	NO
I-SH13-PO01	KS0088510	MARTIN MARIETTA (PF QUARRY)	SMOKY HILL RIVER/UNNAMED TRIB.	LIMESTN	NO
I-SH04-PO03	KS0081311	MARTIN MARIETTA (PW QUARRY)	LOWER SMOKY HILL RIVER	LIMESTN	NO
I-SA22-PO03	KS0088331	ACME BRICK - REMLEY MINE	SALINE RIVER/EAST ELKHORN CREEK	CLAY	NO
I-SH25-PO01	KS0095524	BUILDEX INC. - SHALE QUARRY -MARQUETTE	SMOKY HILL RIVER VIA WEST DRY CREEK	SHALE	NO

APPENDIX B-1: NON-DISCHARGING FACILITIES IN LOWER SMOKY HILL/SALINE BASIN

PERMIT #	FACILITY	DRAINAGE
C-SA20-NO01	RALPH LUTHER MOBILE HOME PARK	SALINE RIVER
C-SA20-NO03	ROLLING HILLS RANCH CONSERVATION CEN.	SALINE RIVER
C-SA20-NO04	SUNDOWNER, INC.	SALINE RIVER
C-SH04-NO02	M & M MOBILE HOME COURT	LWR. SMOKY HILL RIVER
C-SH04-NT01	JOHN'S MOBILE HOME PARK	LOWER SMOKY HILL RIVER
C-SH17-NO02	B C MOTORS	SMOKY HILL
C-SH21-NO01	STUCKEY'S DAIRY QUEEN - STORE #363	SMOKY HILL RIVER
C-SH33-NO02	KOA OF SALINA	SALINE RIVER
C-SH49-NO01	ST. FRANCIS @ SALINA, INC.	SMOKY HILL RIVER
F-SH33-NO01	SMOKY HILL WEAPONS RANGE	SMOKY HILL RIVER
F-SH33-NO01	SMOKY HILL WEAPONS RANGE	SMOKY HILL RIVER
I-SH46-NP01	GREAT PLAINS MFG. - KIPP PLT	LWR. SALINE RIVER
M-KS51-NO01	OGDEN	KANSAS RIVER
M-SA06-NO01	HUNTER MWTP	LWR. SALINE RIVER
M-SA09-NO01	LURAY MWTP	LWR SALINE R VIA WOLF CR
M-SA16-NO01	SYLVAN GROVE MWTP	LWR SALINE R
M-SH07-NR02	KDOT. ELLWSORTH CO. REST AREA	U. SMOKY HILL R
M-SH15-NO02	USD #306 MENTOR SCHOOL	LWR SMOKY HILL R/GYPSUM CCR
M-SH18-NO01	HOPE MWTP	LWR SMOKY HILL R VIA WEST BR. LYON CR
M-SH22-NO01	LONGFORD MWTP	CHAPMAN CR
M-SH24-NO01	MANCHESTER	SMOKY HILL RIVER
M-SH30-NO01	RAMONA MWTP	LWR SMOKY HILL R
M-SH36-NO01	SMOLAN MWTP	LWR SMOKY HILL R
M-SH42-NO01	WOODBINE MWTP	LWR SMOKY HILL R VIA LYON CR
M-SH47-NO01	DICKINSON CO. S.D. #1-TALMAGE	SMOKY HILL RIVER
M-SH51-NO01	FALUN IMPROVEMENT DISTRICT	SMOKY HILL R/UNNAMED TRIB & DRY CR
M-SH52-NO01	ROXBURY IMPROVEMENT DISTRICT	SMOKY HILL RIVER
M-SO27-NO01	KDOT. OTTAWA CO. REST AREA	SALINE RIVER

Appendix C: Phase Two Chloride Mass Balance from Smoky Hill at Enterprise to Kansas River at Ogden

Design Flows at 99% Conditions,
JC-SW@ 625 ppm
Load Analysis for Upper Kansas
River at Ogden

Site	Municipal & Industrial Point Source	Flow (cfs)	Conc(ppm)	T/d WLA	T/d LA	T/d TMDL
Enterprise Station 265		96.78	746.40			195.04
	Enterprise WW	0.14	400.00	0.15		
	Chapman WW	0.39	380.00	0.40		
Chapman Crk Station 515		9.00	33.00		0.80	0.80
Smoky Hill Alluvial Contributions		14.00	40.00		1.51	
	Junction City SW	3.87	625.00	6.53		
Lyon Creek Station 516		9.00	41.00		1.00	1.00
	Grndview Plaza WW	0.29	400.00	0.32		
Smoky Hill Mouth		133.47	570.98	7.41	198.35	205.76
Republican Outflow		28.00	43.00		3.25	
	Camp Forsyth	0.97	150.00	0.39		
	Junction City E	3.87	130.00	1.36		
Republican Mouth		32.84	56.42	1.75	3.25	5.00
Ft Riley Gage		166.31	469.37	9.17	201.60	210.77
	Main Post	1.70	150.00	0.69		
	Custer Hill	2.06	150.00	0.83		
Ogden Station 518		170.07	462.31	10.69	201.60	212.29

Appendix D: Phase Two Chloride Mass Balance on Smoky Hill River from New Cambria to Enterprise

Design Loads at 99% Conditions

Load Analysis for Lower Smoky Hill River above Enterprise

Municipal & Industrial Point Sources

Site	Flow (cfs)	Conc(ppm)	T/d WLALA	T/d TMDL	T/d
New Cambria Gage	40	368.5			39.798
Gypsum Creek Station 641	0.2	80		0.0432	0.0432
Solomon R Station 266	33	380		33.858	33.858
Solomon WWTP	0.17	400	0.18		
VB Interim	0.62	100	0.17		
Holland Creek Station 642	0.1	90		0.0243	0.0243
Mud Creek Station 643	0	40		0	0
Abilene WTF	0.45	80	0.10		
Abilene WWTP	1.95	110	0.58		
Turkey Crk Station 644	0.5	40		0.054	0.054
Smoky Hill Alluvial Contributions	19.79	2250		120.22425	
Enterprise Station 265	96.78	746.38			195.03
Total Loads			1.03	194.00	195.03

Appendix E. Phase Two Chloride Mass Balance for Smoky Hill River and Saline River above New Cambria

Design Flows at 99% Conditions
Load Analysis for Smoky Hill and
Lower Saline above Salina

Municipal & Industrial Point Sources

Site	Flow (cfs)	Conc(ppm)	T/d WLALA	T/d TMDL
Saline-Beverly Station 513	16.03	623.36		26.97
Beverly WWTP	0.07	400	0.08	
Tescott WWTP	0.02	400	0.02	
Tescott Gage	16.12	622.05		
Mulberry Creek Station 640	0.1	422		0.11
Saline Alluvial Contributions	3	200		1.62
Saline-N.Cambria Station 267	19.22	555.13		28.81
Smoky Hill - Mentor Station 514	21	191		10.83
Smoky Hill Alluvial Contributions	-11.5	250		-7.76
Salina WWTP	11.22	260	7.87	
Smoky Hill - Salina Station 268	20.72	195.61		10.94
Scouler Elevator Rem	0.06	300	0.05	
New Cambria Gage	39.99	368.53		39.80
Total Loads			8.0231.77	39.80

Appendix F: Phase Two Chloride Mass Balance for Saline River above Beverly to Wilson Dam, and Wolf Creek

Design Loads at 99% Conditions

Load Analysis for Saline below
Wilson Dam

Municipal Point
Source

Site	Flow (cfs)	Conc(ppm)	T/d WLALA	T/d TMDL
Wilson Dam	7	1000		18.9
Wolf Creek	0.5	950		1.28
Spillman Creek	0	75		0.00
Lincoln WWTP	0.340	400	0.37	
Bullfoot Creek	0	100		0.00
Elkhorn Creek	0	50		0.00
Saline Alluvial Contributions	8.22	292		6.48
Saline-Beverly Station 513	16.06	623.359		27.03
Total Loads			0.3726.66	27.03